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THESIS

A STUDY OF SPECTRUM LOADING AND RANGE-PAIR COUNTING METHOD EFFECTS ON CUMULATIVE FATIGUE DAMAGE

by

John Scott Atkinson, Jr.

March 1977

Thesis Advisor: G. H. Lindsey

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A Study of Spectrum Loading and Range-Pair Counting Method Effects on Cumulative Fatigue Damage

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requirements for the degree of

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This thesis is a study of cumulative fatigue damage. Variations in cumulative fatigue damage resulting from block loading spectra and randomized cycle loading spectra are investigated. Fatigue damage results show the merit of counting load cycles using the range-pair counting method. Complete FORTRAN computer program documentation enables this thesis to serve as a program user's manual.

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LIST OF SYMBOLS

A	Coefficient of the x^2 term in the equation of a line on a constant life fatigue diagram where minimum stress is x and maximum stress is y. $(R = Ax^2 + Bx + C - y)$
AA	An assigned value of +1. or -1.
AAA	A stress used in the calculation of plastic strain.
ABDIF	The absolute value of DIF.
ABM	The absolute value of ASMAX or of ASMIN, as assigned.
ABMAX	The absolute value of ASMAX.
ABMEAN	The absolute value of ASMEAN
ABMIN	The absolute value of ASMIN.
ABR4	The absolute value of R(4).
ABR7	The absolute value of R(7).
ABS	The name of a routine calling for the absolute value of a quantity.
AKT	Stress concentration factor, K_t.
ASMAX	The product (AKT)(STMAX).
ASMEAN	The quantity (ASMAX + ASMIN)/2.
ASMIN	The product (AKT)(STMIN).
AVSGMN	Average value of SIGMIN over an interval.
AVSGMX	Average value of SIGMAX over an interval.
B	Coefficient of the x term. (see A)
BBB	A stress used in the calculation of plastic strain.
C	The constant. (see A)
COFMAN	Inverse of the Coffin-Manson slope.
CYCINT	The number of cycles in an interval.

CYCLES	The calculated number of cycles expected to be indicated on a constant life fatigue diagram for the applied combination of maximum and minimum stress.
C1	The Residual Stress Relaxation Constant. (see ENEP)
DAM	Damage.
DECK	Decimal or real value of integer K after conversion.
DEL2	A portion of a least-squares-method solution.
DIF	The difference between residual stress and equilibrium residual stress. (RES(I) - EQRES)
DO2	A portion of a least-squares-method solution.
DUMMY	A variable used in the calculation of the number of cycles to be considered as an interval for relaxation determination.
ELMOD	The elastic modulus.
EN	The number of cycles from the beginning of the relaxation process to the end of the current interval.
ENEP	The number of cycles required for overload residual stress effect to return to within one-tenth of its original difference from equilibrium conditions. $(N_{ep} = C1/(ABM)^{E1}\ (ABMEAN)^{E2})$
ENN	The number of applied cycles at a load level.
ENNCYC	The ratio of the number of applied cycles to the number of cycles to failure. (ENN/CYCLES)
EPSD	LCF strain intercept.
EQRES	Equilibrium residual stress.
EX	An exponential function depicting the relaxation of residual stress.
EXP	The name of a routine calling for the exponential value of a quantity.
EXPO	An exponent. The power of 10 which indicates the number of cycles to failure.
E1	Residual stress relaxation exponent.
E2	Residual stress relaxation exponent.

FLOAT	The name of a routine calling for integer-to-real conversion.
I	A variable subscript.
IBLOCK	The identifying number of a block, the blocks being numbered consecutively from 1 to NBLOCK.
IFIX	The name of a routine calling for real-to-integer conversion.
IN	The number of steps input to the range-pair counting subroutine.
IPRINT	Value controlling the WRITE statements.
IRAIN	A counter.
IRPCM	Value controlling entry into the range-pair counting subroutine.
ISTEP	The identifying step number, the steps being numbered from 1 to NLEVEL.
ITYPE	The identifying type number, the types being numbered from 1 to NTYPE.
J	A variable subscript.
JA	Value of +1 or 0, as assigned for branch determination.
JB	Value of -1 or 0, as assigned for branch determination.
JJ	An index variable.
JJJ	An index variable.
JKL	An index variable.
K	An index variable.
KK	An index variable.
KPMAX	The number of steps output from the range-pair counting subroutine.
L	An index variable.
LMN	An index variable.
M	An index variable.
N	An index variable with values of N=4-7 indicating the power of 10, and thus identifying a particular life cycle curve.

NBLOCK	The total number of times to execute a block of loads.
NDECK	The number of data decks to be run sequentially.
NFLAG	An integer used as a counter.
NFLAG2	An integer used as a counter.
NLEVEL	The total number of steps, or levels, of loads in a block.
NN	A subscripted variable used to indicate which types of loads are experienced in which blocks.
NTYPE	The total number of different types.
PLSTRA	Plastic strain.
R	Residue term in damage calculation.
RES	Residual stress.
RNCYC	The number of cycles for a level after exitting the range-pair counting subroutine.
SIGMAX	Maximum stress.
SIGMIN	Minimum stress.
STMAX	Maximum applied stress.
STMIN	Minimum applied stress.
SUMDEL	Summation of damage for a flight.
SUMENN	Accumulated total of applied cycles. (Summation of ENN)
SUMNC	Accumulated cycle ratio. (Summation of ENN/CYCLES)
SUMR	Summation of R(N), N=4,7.
SUMRN	Summation of NR(N), N=4,7.
SUMR2	Summation of $R(N)^2$, N=4,7.
SUMR2N	Summation of $NR(N)^2$, N=4,7.
SUMR3	Summation of $R(N)^3$, N=4,7.
SUMR4	Summation of $R(N)^4$, N=4,7.
TITLE1	Identification of the source of the S-N data.

TLL	Tensile limit load.
TM1,TM2	Material type.
TTYS	One-fifth of tensile yield stress.
TYS	Tensile yield stress.
T1,T2	Test identifying information.
X	Variable equivalent to SIGMIN.
Y	Variable equivalent to SIGMAX.

I. INTRODUCTION

In an aircraft fatigue life monitoring program, determination of the actual loading environment which produces the fatigue is a major problem. With both military trainer and fighter aircraft, which may be used for a variety of duties, regular or continuous load recording programs have to be considered mandatory. Such load recording programs provide the data to calculate the consumed fatigue life of operating aircraft and are used in selecting design spectra for future aircraft designs.

To facilitate the calculations of fatigue life from such data, it is important to know not only the loading magnitudes but also the time sequence of the loading. The fatigue life of a local critical point varies due to residual stresses remaining after the application of a load causing local plasticity in tension or compression. For instance, a peak tensile load into the plastic flow region leaves a residual compressive stress, which lowers the local magnitude of the following tensile stresses, thus increasing the fatigue life. In a similar manner a peak compressive load into the plastic flow region, if it were to occur, would leave a residual tensile stress, which decreases the fatigue life.

Currently, fatigue monitoring of naval aircraft is based on the total number of g readings recorded at four

selected levels by an exceedence level counting accelerometer. Using micropressors in the near future it will be possible to record each maximum and minimum load level experienced by an aircraft in sequence. The data collected can be used to monitor the fatigue life of a structure via the determination of damage accumulated at a point found to be critical in a structural test of a prototype. It should be noted that this calculation uses a theoretical model. Damage is not observable or measurable.

The objective of this thesis is to use a computer program, employing the range-pair counting technique on time sequence recorded maximum and minimum aircraft loads and a relaxation model to consider residual stresses, to calculate plastic, elastic, and total aircraft structural damage.

II. GENERAL DESCRIPTION OF THE COMPUTER PROGRAM

The computer program used in this fatigue analysis is divided into four modules. Each module is clearly labeled in the program listing (page 93). In module I the input data are read and assimilated in preparation for future calculations. The input parameter requirements are presented in detail beginning on page 18, and six sample sets of input data are illustrated starting on page 40.

When the load sequence randomization technique is used to input loading data, it is a part of module I. The load sequence randomization technique uses the computer library subroutine RANDU to place 10 percent of the MIL spectrum A positive loads (Table I) in a random order. Each of the positive loads is paired with a minimum load of 11 percent limit load, or 1-g. During the randomization each load has an equal probability of selection. A counter restricts the number of times a value is selected to the number of occurrences of the particular load level in MIL spectrum A.

Two variations on the randomization of the MIL spectrum A load levels are available. The first option permits randomization of the negative MIL spectrum A load levels using the same technique as in the case of the positive MIL spectrum A load levels. Each negative load level is randomly paired with a positive load level. Since there are not as many negative load levels in MIL spectrum A as

TABLE I

FREQUENCY OF MANEUVER LOADS

NUMBER OF TIMES PER THOUSAND HOURS THAT
LOAD FACTOR IS EXPERIENCED

PERCENT OF MAXIMUM (POSITIVE) SYMMETRICAL LIMIT LOAD FACTOR	FLIGHT MANEUVER LOAD SPECTRUM A
35	17000
45	9500
55	6500
65	4500
75	2500
85	1360
95	440
105	150
115	40
125	16
TOTAL	42006

PERCENT OF MAXIMUM (NEGATIVE) SYMMETRICAL LIMIT LOAD FACTOR	FLIGHT MANEUVER LOAD SPECTRUM A
0	500
10	200
20	100
30	60
40	35
50	30
60	25
70	20
80	15
90	10
100	5
110	3
TOTAL	1003

there are positive load levels, the excess load levels are paired with 1-g loads. Mixing of the negative MIL spectrum A load levels and the 1-g load levels is accomplished using the computer library subroutine RANDU. For this ordering there is an 80 percent chance that each negative load selected will be a 1-g load. A counter ensures the proper numbers of each load type are included. Eighty percent probability of selection of a 1-g load was used to spread the smaller number of negative MIL spectrum A loads throughout the sequence, and also to speed computer operation by not having the matrix of negative MIL spectrum A loads addressed so often, after the counter indicated the matrix elements had all been used.

The second option for randomizing loads provides for the inclusion of a ground cycle between each flight. The ground cycle loading is taken as -2500 psi, or -8 percent limit load. Eight percent is the level of the ground cycle load used by the A7 manufacturer. There are 4201 positive loading events in 100 hours of MIL spectrum A flight time. Each flight is arbitrarily taken as one hour in length, so a ground load is paired with every forty-second positive loading event.

In module II the local stresses and strains are determined from the input data. If the local peak stress is in the plastic region, the specimen is assumed to unload elastically, leaving a local residual compressive stress in the material. In the analysis developed by Potter [Ref. 6],

the transient portion of the residual stress so produced relaxes toward zero, or an equilibrium residual stress. After the stresses and strains are calculated, the local stress cycles are counted in module III using the range-pair counting technique. In module IV the fatigue damage is calculated. Damage is determined separately for elastic and plastic strain events. The elastic and plastic damage for each flight is listed as output, as well as the total cumulative damage from any previous flights.

A. INPUT DATA REQUIREMENTS (MODULE I)

Samples of data are listed starting on page 40; formatting is described beginning on page 93. Both pages should be consulted while reading the following descriptions.

1. Data Card 1

Only one of these cards is required or permitted for each program run.

NDECK = the number of data decks to be run sequentially. The input on this card will be common to all data decks run. It is not necessary for the different data decks to have any parameters in common.

IPRINT = the value controlling the write statements. Output available during the process of the analysis includes:

a. Maximum and minimum applied stress of each cycle and the local stress response throughout the spectrum. Also printed out is the residual stress, equilibrium stress, applied cycles, and the equilibrium period for each cycle.

b. The elastic local stress history as input into the range-pair subroutine and the resulting range-paired spectrum.

c. The maximum plastic strain occurrence during the spectrum and the damage associated with each strain reversal.

d. The accumulated damage associated with the plastic strains.

e. The range-paired elastic stress spectrum and the damage associated with each level for block loading, or for each cycle for RANDU generated loadings.

f. The accumulated damage associated with the current block of loading, including the plastic strain damage, and the total damage since the initiation of cycling.

The value assigned to IPRINT controls which pieces of data are included in the printout.

If IPRINT = 1, all six items listed above are printed for each flight or block of loads.

If IPRINT = 2, all items listed above except b, are printed.

If IPRINT = 3, only items d and f listed above are printed.

An example of each output option is given beginning on page . When the number of loads is more than fifty, the output is quite voluminous, and a paper usage default may interrupt program operation. With large numbers of loads, IPRINT should be set equal to 3.

IRPCM = the value controlling entry into the range-pair counting subroutine.

If IRPCM = 1, the range-pair counting method is used.

If IRPCM = 2, the range-pair counting method is skipped.

Each data deck run sequentially must contain the following cards. The number of data decks was indicated by the value assigned NDECK.

2. Card 1

Information on this card is descriptive, alphanumeric data used only as a heading test identification.

3. Card 2

The name of the material type and four material constants are listed on this card. The material type is an alphanumeric entry. The tensile yield stress, LCF strain intercept, inverse of the Coffin-Manson slope, and the modulus of elasticity are real number entries. The LCF strain intercept is the numerical value of the ordinate intercept in the log-log Coffin-Manson plot of plastic strain range vs. cycles to failure. Units of tensile yield stress and modulus of elasticity are ksi.

4. Cards 3 Through 6

Each card contains the three coefficients of a second order least-squares curve fit for S-N data obtained from a Goodman diagram published in MIL-HDBK-5A. The curves are fit for lives of 10^4, 10^5, 10^6, and 10^7 cycles. Space is provided on each card for an alphanumeric indication of

the data source. Only the data source printed on card 6 will be retained in computer storage for subsequent printout. Columns 72 through 80 are used for information only and are not read by the computer.

5. Card 7

Constants to be used in the equilibrium period calculations are listed on this card.

6. Card 8

The stress concentration factor is the only entry on this card.

7. Card 9

The first entry on this card is the number of blocks of loads, or the number of flights. The terms block and flight are used interchangeably. This entry is the number of times the list of loads is to be repeated. The next entry is the number of loads. The number of loads will always be the same as the quantity of cards 11 used as input. The last entry is the number of types of loads. Loads are indicated as being a different type in order to alter the loading pattern during subsequent flights. It is important to understand that the program will always consider load types in ascending numerical order. A flight listing load types in the order 1, 2, 3, 4 will produce identical results with a flight listing load types in the order, 4, 3, 2, 1.

8. Card 10

Only the limit load is listed here, with units of ksi. The maxima and minima of all cycles are input as a decimal fraction of this load entry.

9. Cards 11

Information identifying each load cycle is presented on these cards. The first entry is an integer representing the step, or number of the load. This integer increments by one on each card, with the last card having a value equal to NLEVEL. Other entries on these cards are the type of load, the minimum and maximum decimal fraction of the limit load for the particular step, and the number of consecutive cycles at this load level. It is important to notice that the format requires the number of cycles to be entered as a real number, although fractions of cycles will not be processed.

10. Cards NLEVEL + 11

The first entry is an integer representing the number of the block, or flight. This entry is a dummy variable and is not used in any subsequent calculations. The other entries on this card indicate which types of loads are to be processed on this particular flight. Each type of load may be processed only once on each flight. The order in which the types are listed is of no significance, since the load types are automatically processed in ascending numerical order.

B. RANGE-PAIR COUNTING METHOD

In assessing the life consumed by an individual aircraft, damage is calculated from Miner's Law using S-N data. This type of life calculation is of greater value if the cycle counting method used takes into account the actual load-time

history of the aircraft. Many load cycle counting methods have been developed and used. Fatigue test experience indicates that a useful counting technique for aircraft fatigue must take into account the loading sequence as well as the magnitude of the maximum and minimum load peaks [Ref. 10]. The two most realistic counting techniques are the range-pair counting method and the rain-flow counting method. Both methods experimentally yield approximately the same results. The major difference between the two methods is that the rain-flow method counts in terms of load ranges, or half cycles, whereas the range-pair method records the time history in terms of complete load cycles. When counting in terms of full cycles, the two methods are equivalent. The merit of counting half cycles is not important when analyzing aircraft fatigue because the large number of load reversals does not permit a half cycle to influence the numerical results. The range-pair counting method corresponds to the stable cyclic stress-strain behavior of a material in that strain ranges counted as cycles will form closed stress-strain hysterisis loops [Ref. 4].

The computer program employed in this thesis has the option of using the range-pair counting method, or simply using each peak in the order that it occurs. When the range-pair counting method is not used, only momentary load values are considered, and information regarding the cyclic stress-strain pattern, which is important in fatigue calculations, is lost. Also, minor load variations, which are of little

importance in fatigue calculations, are counted as additional cycles.

The range-pair counting method is illustrated in Figure 1. It counts a strain range as a cycle if it can be paired with a subsequent straining of equal magnitude in the opposite direction. For a complicated load history, some of the ranges counted as cycles will be simple ranges, such as 2-3, during which the strain does not change direction, but others, such as 1-8, will be interrupted by smaller ranges which will also be counted as cycles. In Figure 1 ranges are marked with solid lines and the paired ranges with dashed lines.

Each peak is taken in order as the initial peak of a range, except that a peak is skipped if the part of the history immediately following it has already been paired with a previously counted range. If the initial peak of a range is a minimum, a cycle is counted between this minimum and the most positive maximum which occurs before the strain becomes more negative than the initial peak of the range. For example, in Figure 1 a cycle is counted between peak 1 and peak 8, peak 8 being the most positive maximum that occurs before the strain becomes more negative than peak 1. If the initial peak of a range is a maximum, a cycle is counted between this maximum and the most negative minimum which occurs before the strain becomes more positive than the initial peak of the range. For example, in Figure 1 a cycle is counted between peak 2 and peak 3, peak 3 being the most negative minimum before the strain becomes more

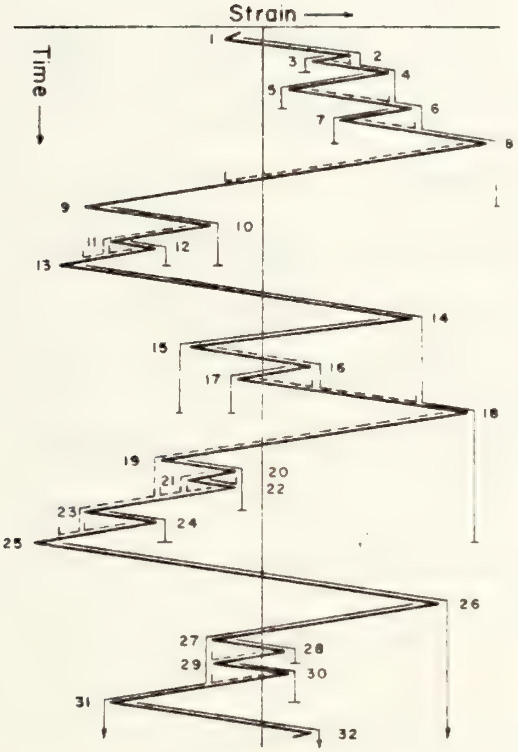
Strain
Time
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
22
21
23
24
25
26
27
28
29
30
31
32

Figure 1

Illustration of Range-Pair Counting Method

positive than peak 2. Each range that is counted is paired with the next straining of equal magnitude in the opposite direction, explaining why complete cycle rather than half cycle counts are made. For example, in Figure 1 part of the range between peaks 8 and 9 is paired with the range counted between peaks 1 and 8.

C. DAMAGE CALCULATION

Damage due to plastic strain and damage due to elastic strain is calculated separately. The behavior of the specimen is assumed to be elastic-perfectly plastic as illustrated in Figure 2. Behavior in compression is assumed to be the same as the behavior in tension. The total damage is determined using the Miner's summation $D = \Sigma n/N$ where

D = total damage

n = number of cycles at a particular load level

N = number of cycles to failure at a particular load level

Failure of the specimen is defined as occuring when D equals unity.

Plastic strain damage is calculated using the Coffin-Manson theory [Ref. 5]. The Coffin-Manson theory is based on an experimentally determined log-log plot of plastic strain range vs. cycles to failure as shown in Figure 3. The slope of the line in Figure 3 is approximately -1/2 for all metals, with the ordinate intercept making the behavior of each metal unique. The equation used for calculation of plastic strain damage is

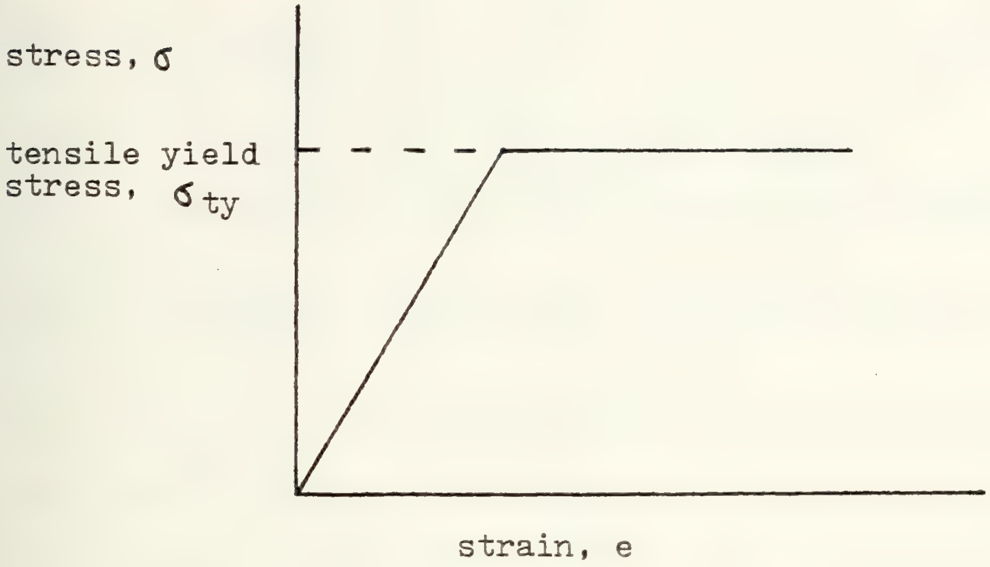
stress, σ
tensile yield stress, σ_{ty}
strain, e

Figure 2. ELASTIC-PERFECTLY PLASTIC BEHAVIOR

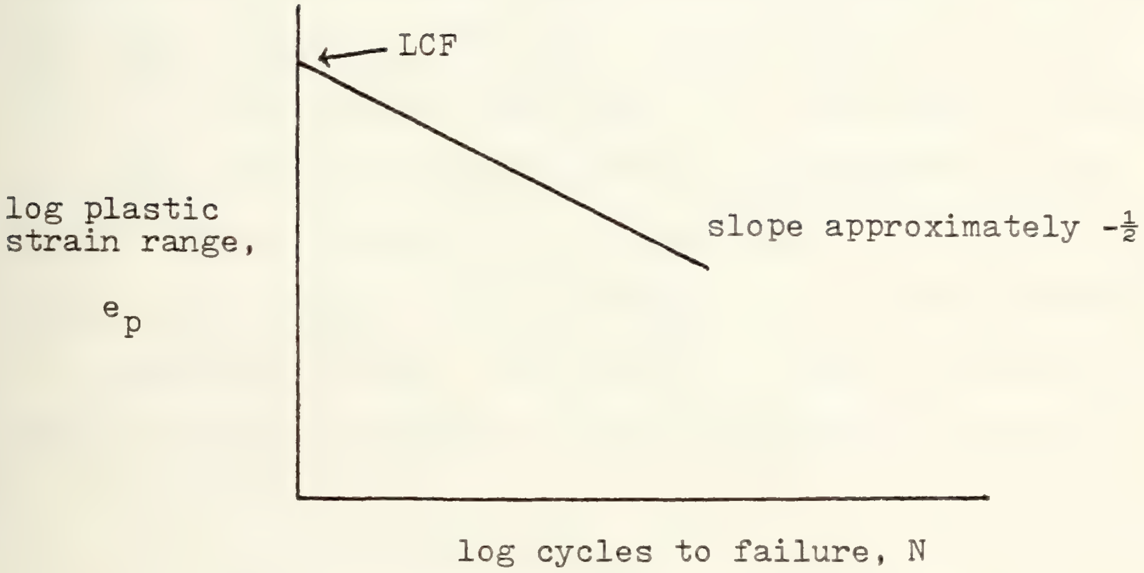
LCF
log plastic strain range, e_p
slope approximately $-\frac{1}{2}$
log cycles to failure, N

Figure 3. COFFIN-MANSON DIAGRAM

$$N = (e_p / c)^{k^{-1}}$$

where N = number of cycles to failure at a specific plastic strain

e_p = magnitude of the plastic strain

k = slope of the Coffin-Manson curve, approximately - 1/2

c = ordinate intercept; experimentally for each metal type

For strain levels in the plastic range, failure occurs in less than 10^4 cycles, and damage is calculated using the Coffin-Manson theory. For strain levels in the elastic range, the Goodman diagram is the basis for calculation of damage. The maximum and minimum local strain levels are sequentially compared with second order least-squares curve fit data from the Goodman diagram. The curve fits used are for lives of 10^4, 10^5, 10^6, and 10^7 cycles [Ref. 3]. The elastic damage is totaled using the Miner summation and combined with the plastic damage, computed in a similar way, to yield the total damage. The amount of plastic damage and the total damage for a particular flight, and the total damage including all previous flights is printed at the end of each flight.

III. DISCUSSION OF RESULTS

The load spectrum used in this analysis is the load spectrum A from MIL-HDBK-5A, and the loads are assumed to be applied at wing station 32 on an A7 aircraft wing [Ref. 2]. Load data were input as block loads and also as single randomized cycles. The Miner's Law summation of fatigue damage for this loading spectrum is .1300 per 1000 flight hours. Results obtained using this computer program are given in Tables II, III, and IV. It is important to notice that when fatigue damage is calculated without using the range-pair counting method, it makes only a minor difference on the total fatigue damage when the sequence of loading is changed or when negative loads are included.

Block loads were arranged in LO-HI, HI-LO, and HI-LO-HI sequences. The results indicate the LO-HI sequence to be more damaging than the HI-LO sequence, with damage due to the HI-LO-HI sequence falling between the other two block load sequences. In the HI-LO sequence the HI loads leave a local residual compressive stress in the material, and the LO loads do less damage.

In the case of RANDU generated load sequences, identical starter integers were used in order to evaluate the effect on the damage of inclusion of MIL spectrum A negative loads and ground cycles. The more negative loads that are included, the worse is the fatigue damage. The increase in damage with more negative loads is caused by the negative loads decreasing

TABLE II

FATIGUE DAMAGE DUE TO POSITIVE MILSPEC A BLOCK LOADING, NORMALIZED TO 1000 HOURS

SEQUENCE OF BLOCK LOADS	USING RPCM*	NOT USING RPCM*
LO-HI	.16780102	.16780108
HI-LO	.069243014	.069243014
HI-LO-HI	.10864216	.10839599

* RANGE-PAIR COUNTING METHOD

TABLE III

FATIGUE DAMAGE DUE TO MILSPEC A RANDOMIZED LOAD INPUTS, USING RPCM, NORMALIZED TO 1000 HOURS

INTEGERS USED TO START RANDU	MINIMUM LOAD VALUES		
	11 PERCENT LIMIT LOAD	NEGATIVE MILSPEC A	GROUND CYCLES
83745,54711,54487	.039226338	.046267733	.060848035
13547,66549,7	.095124505	.085063167	.10429338
9,583,4777	.043321513	.043640956	.036781987
48621,3,491	.018672124	.034077277	.035881512
73,559,1001	.031819174	.042006299	.037130679
357,833,1	.037665060	.049336702	.050973855

TABLE IV

FATIGUE DAMAGE DUE TO MILSPEC A RANDOMIZED LOAD INPUTS, NOT USING RPCM, NORMALIZED TO 1000 HOURS

INTEGERS USED TO START RANDU	MINIMUM LOAD VALUES		
	11 PERCENT LIMIT LOAD	NEGATIVE MILSPEC A	GROUND CYCLES
83745,54711,54487	.040602274	.047398917	.049124956
13547,66549,7	.040137805	.047727041	.049612150
9,583,4777	.041204430	.048346408	.049540661
48621,3,491	.041160211	.049230121	.050957575
73,559,1001	.040792227	.047043338	.049311966
357,833,1	.041056350	.049220584	.050481893

the local residual compressive stress caused by positive loads into the plastic zone. This permits the local positve elastic stresses to be more damaging.

Six plots are presented, beginning on page 33, to illustrate the pattern of the individual load randomization process. Each plot portrays the first two flight hours of the aircraft. The range of values in the columns of Table III are caused by such variations in the load randomization pattern.

The fatigue damage resulting from randomization of loads on a cycle basis, as shown in Table III, is significantly different from the damage due to the HI-LO-HI block loads illustrated in Table II. Vought Aeronautics Division conducted a fatigue study using randomized flights. Each flight was based on a mission profile specified by the Air Force. Fatigue damage resulting from the randomized flights was in close agreement with fatigue damage resulting from HI-LO-HI block loading.

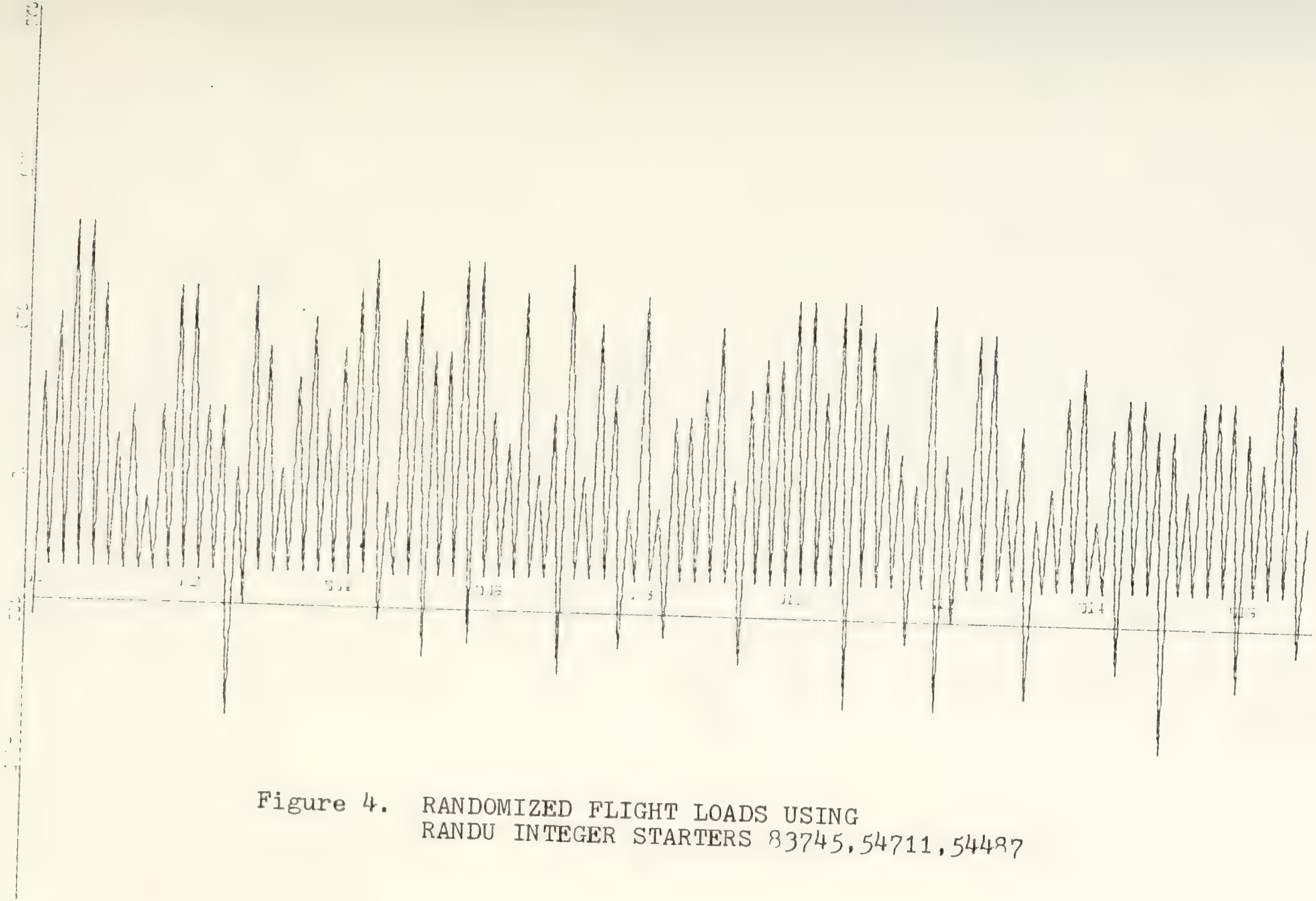

Figure 4. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 83745,54711,54487

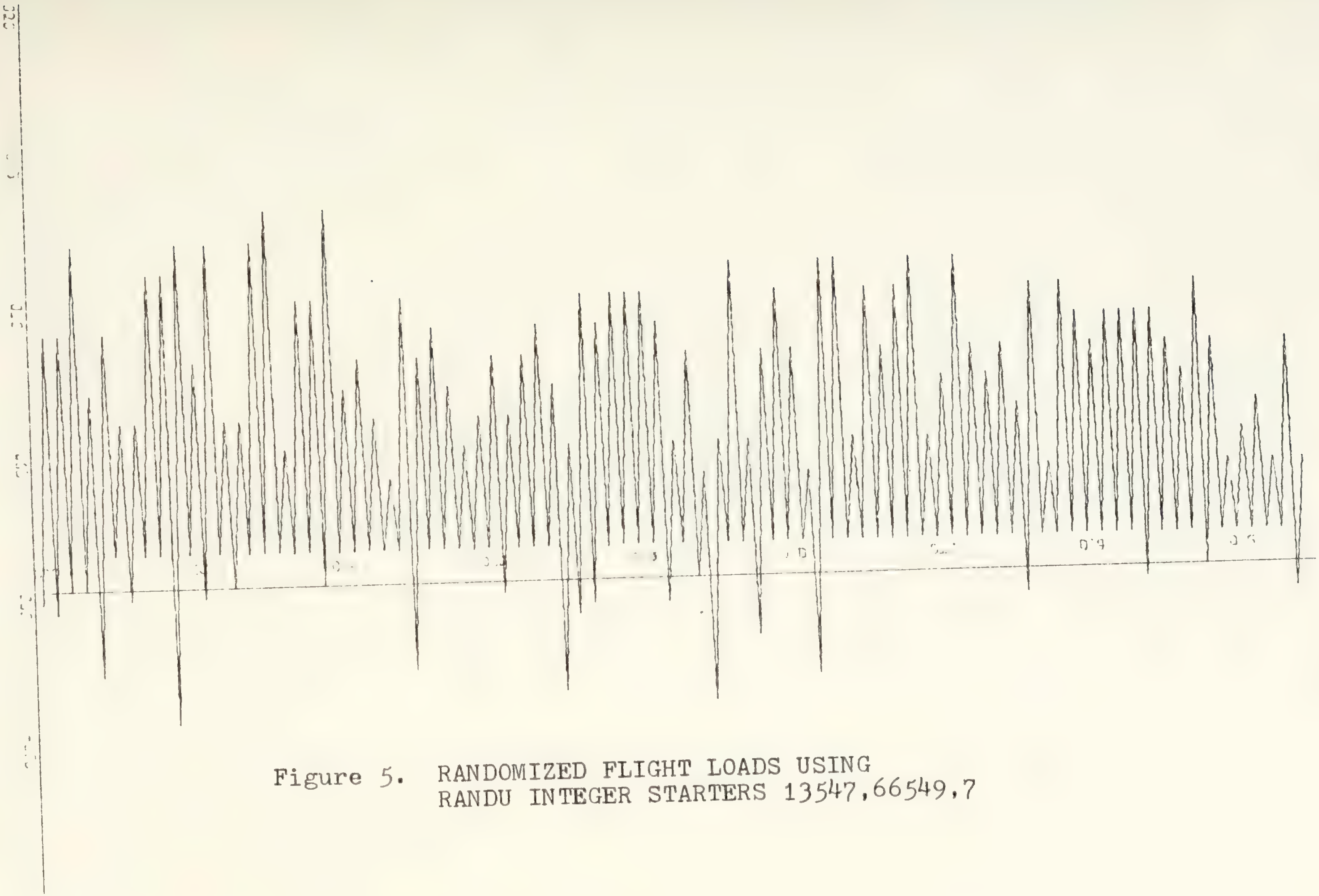

Figure 5. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 13547,66549,7

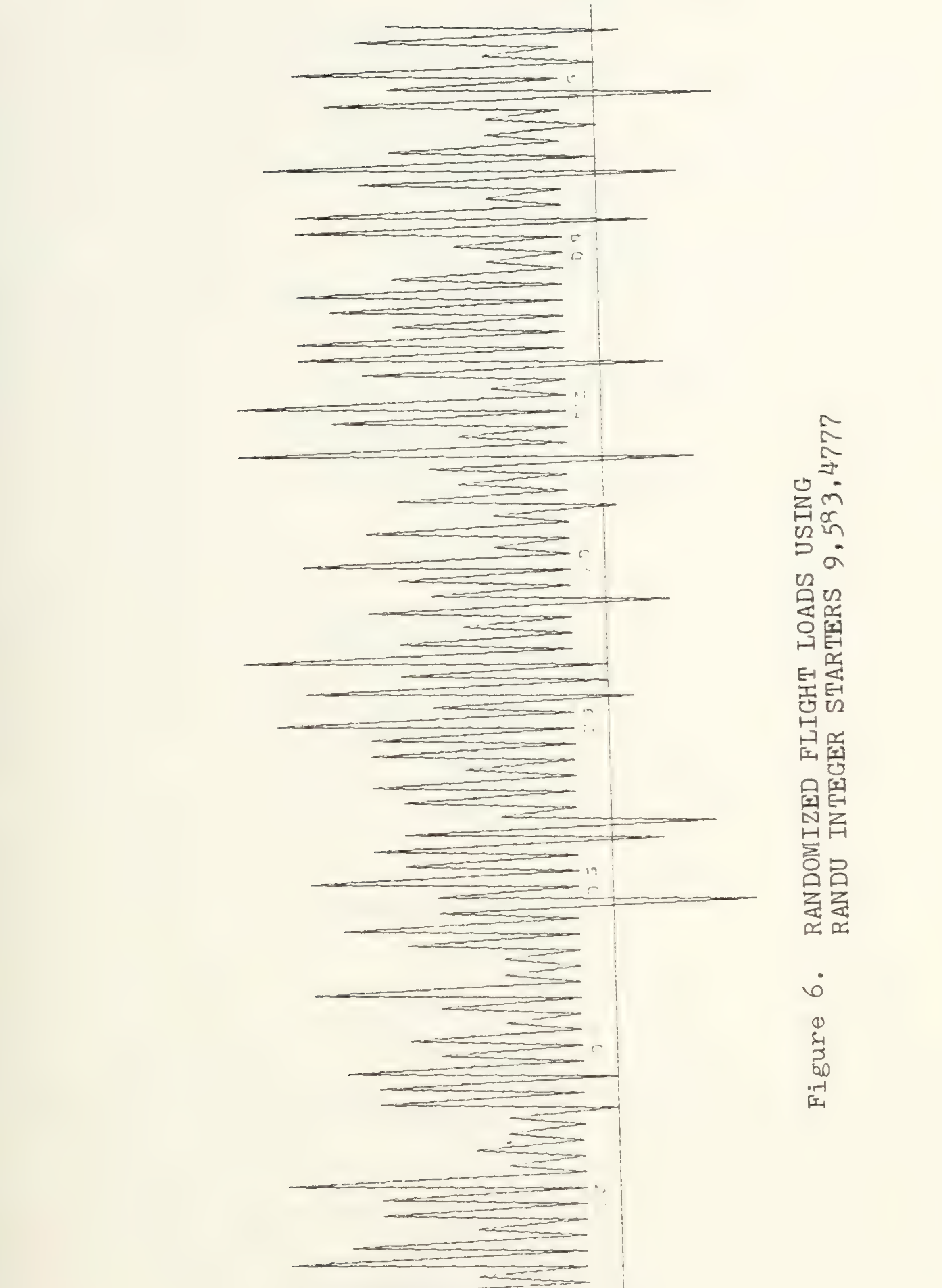

Figure 6. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 9,583,4777

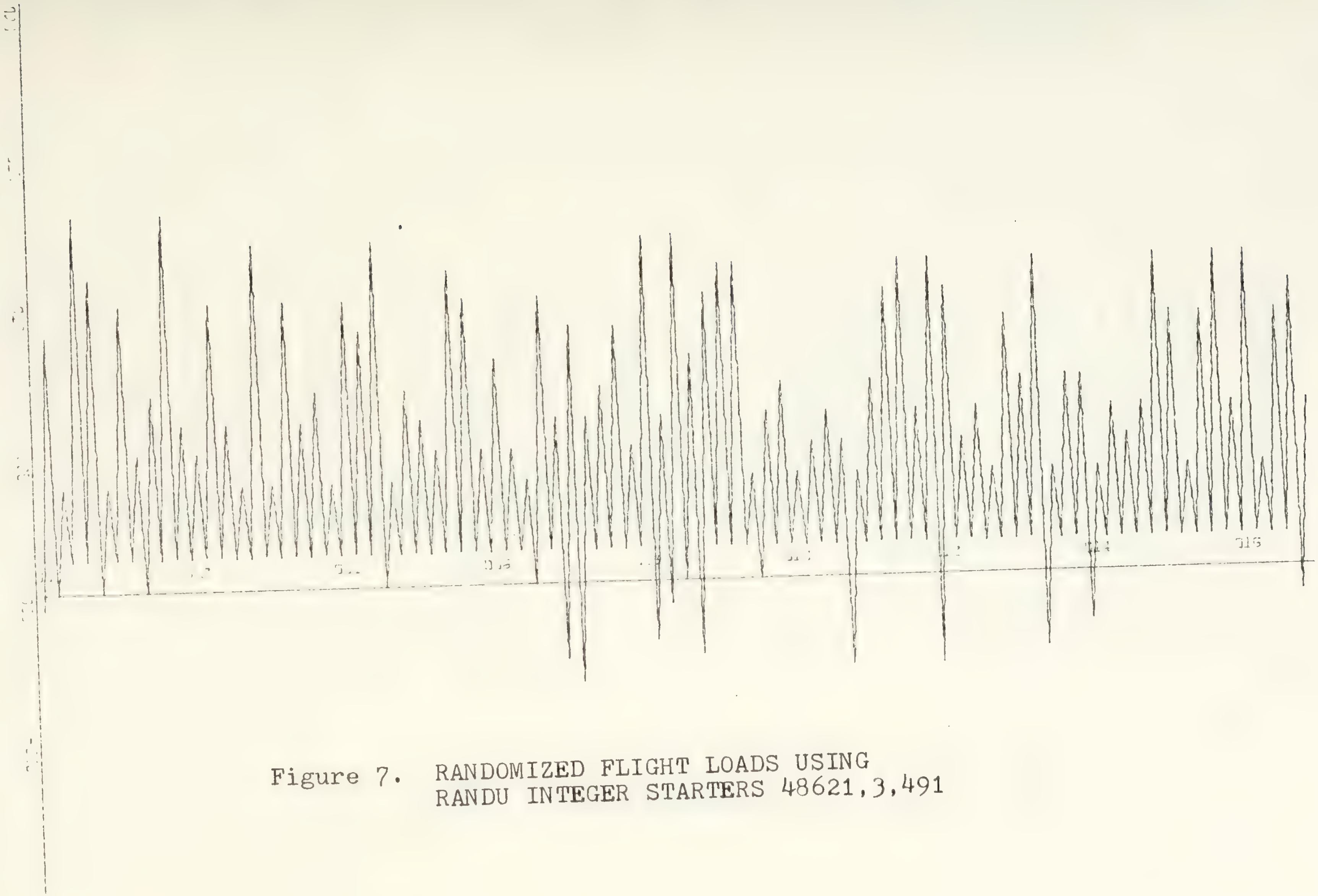

Figure 7. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 48621,3,491

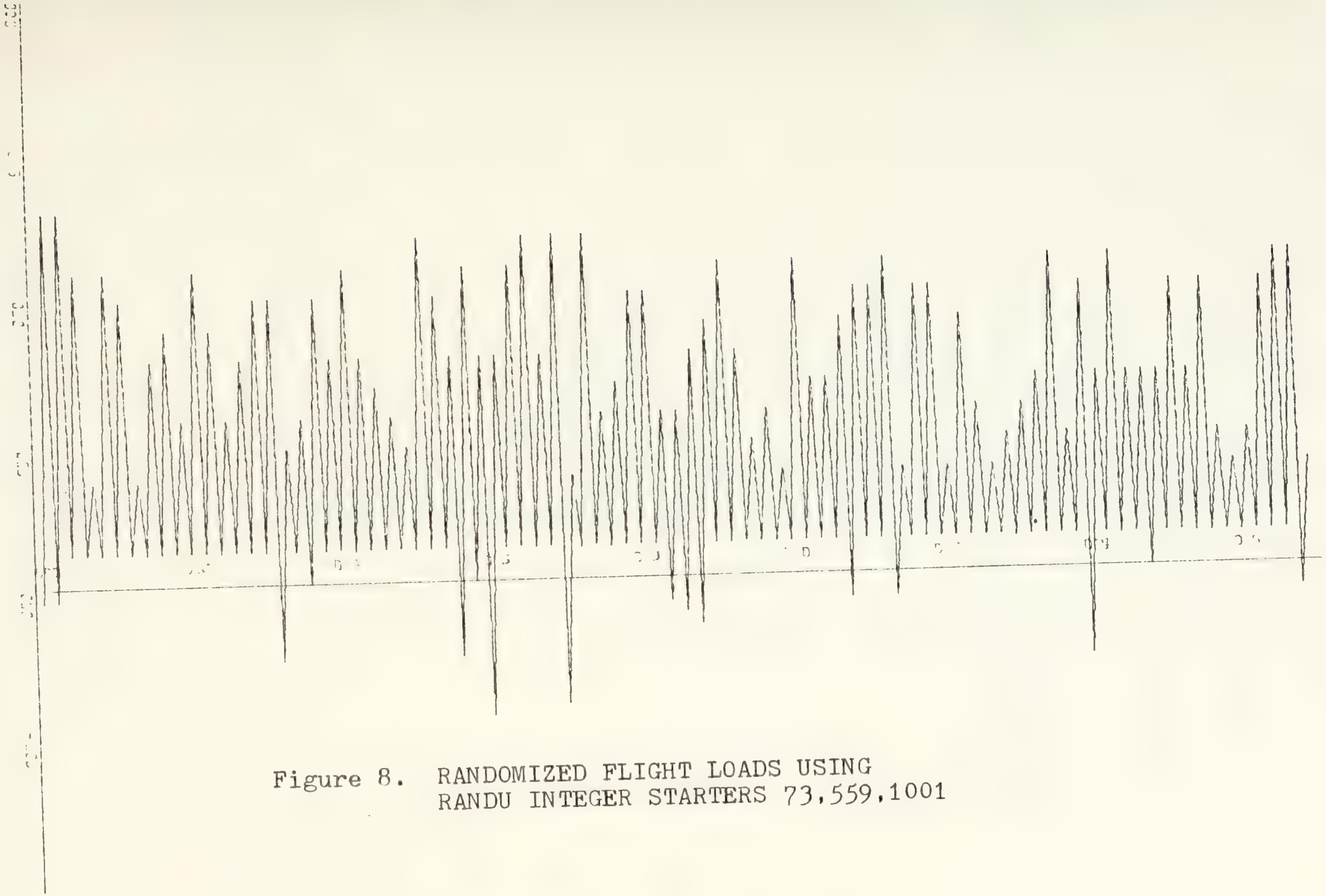

Figure 8. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 73,559,1001

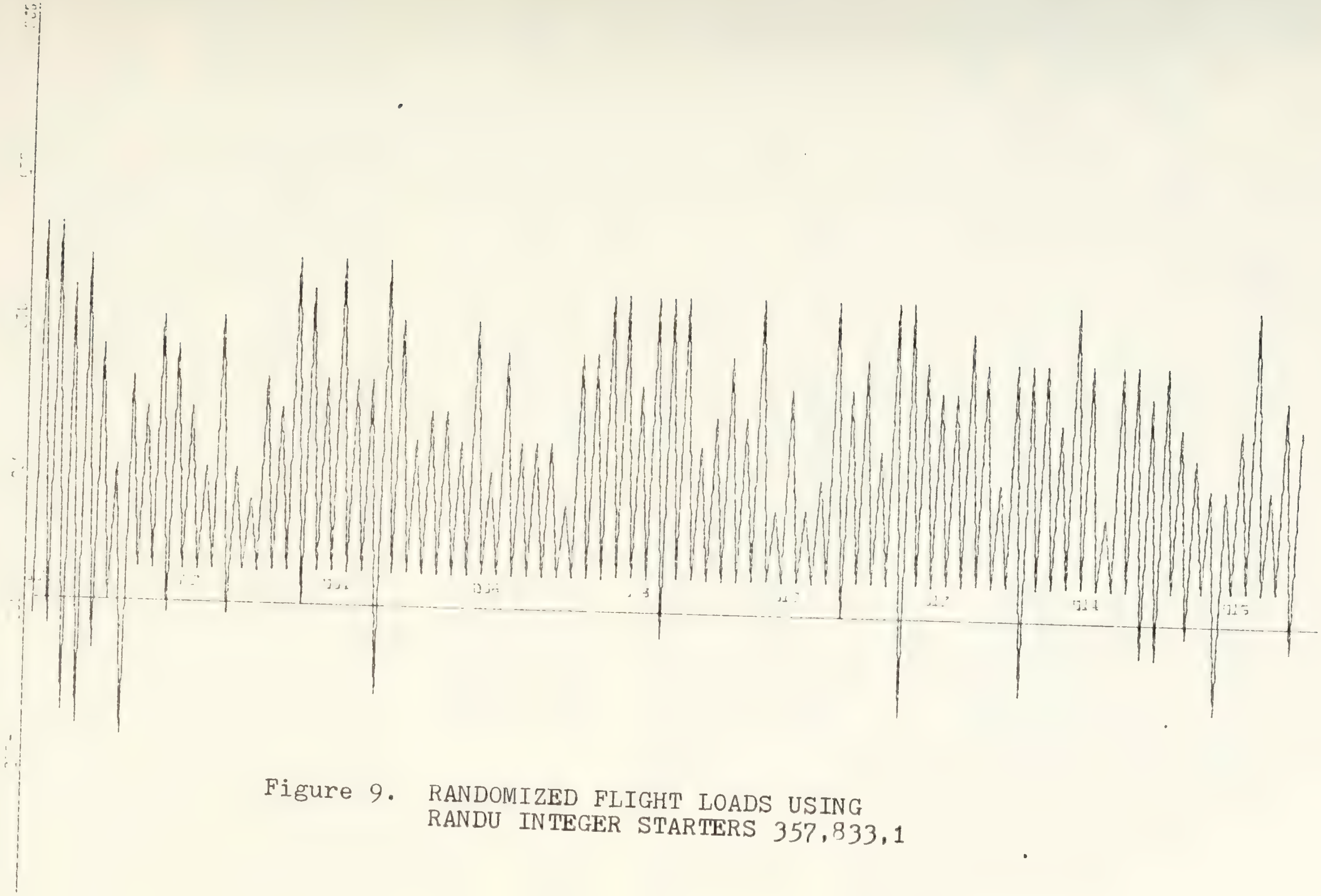

Figure 9. RANDOMIZED FLIGHT LOADS USING RANDU INTEGER STARTERS 357,833,1

IV. RECOMMENDATIONS FOR FUTURE RESEARCH

Subsequent work in this area should be directed toward refining the input load sequence. The Naval Air Development Center collects accelerometer data from individual aircraft on a monthly basis. These load data could be used in this computer program to see if randomizing the load sequence over the life of the structure provides a different picture of the fatigue damage than randomizing by the month. Also, research is needed to determine the magnitude and sequence of the ground cycles. In this analysis all ground cycles were considered of equal magnitude and equal spacing, which is not the case with a real airplane. A landing load spectrum should be used to be more accurate.

The computer program itself could be improved by a better understanding and definition of the relaxation phenomena. Experiments to quantify the relaxation parameters will enhance the program.

The Air Force is monitoring crack growth as the basis for their fatigue damage assessment. It would be productive to compare the total fatigue damage calculated by the two methods.

COMPUTER OUTPUT

```
INPLT CF BLOCK LOADS


   1   1   1
A7 CRITICAL POINT #1 FROM U166808
7075-T6 AL                     72.               C.4            -1.836    10000.
            -.0020             .2801              71.7MIL-HDBK-5A       4 7075
            -.0022             .5154              56.3MIL-HCBK-5A       5 7075
            -.0014             .6141              44.6MIL-HDBK-5A       6 7075
            -.0013             .6838              38.1MIL-HDBK-5A       7 7075
         10000000.                1.                1.
              2.72
         2        10        10
              29.8
   1     1                 .11               1.25                16.
   2     2                 .11               1.15                40.
   3     3                 .11               1.05               150.
   4     4                 .11                .95               440.
   5     5                 .11                .85              1360.
   6     6                 .11                .75              2500.
   7     7                 .11                .65              4500.
   8     8                 .11                .55              6500.
   9     9                 .11                .45              9500.
  1C    1C                 .11                .35             17000.
    1   1C    9    8    7    6    5    4    3     2    1
    2    1    2    3    4    5    6    7    8     9   10
```

```
OUTPUT OF BLOCK LOADS, IPRINT = 1



   1 DATA DECKS ARE TO BE PROCESSED.

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FRCM  A7 CRITICAL PCINT #1 FROM U166808.
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --          72.00000

LCF STRAIN INTERCEPT =            0.40000

INVERSE CF COFFIN-MANSON SLOPE          -1.83600

ELASTIC MCDULUS =       10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE               A(I)                B(I)                C(I)
   1C** 4            -0.00200            0.28010            71.7C000
   1C** 5            -0.00220            0.51540            56.29999
   10** 6            -0.00140            0.61410            44.59999
   10** 7            -0.00130            0.68380            38.09999

UNNOTCHEC COUPON S-N DATA DERIVED FROM
INFCRMATICN SUPPLIED FRCM  MIL-HDBK-5A

RESIDUAL STRESS RELAXATION FUNCTION

    ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = C.10000000E 08 ,   E1 =     1.000 ANC  E2 =     1.000


        2 TIMES THROUGH BLOCK OF        10 LOADS

     LOAC LIMIT =           29.79999


STEP  TYPE              STMIN               STMAX               ENN
   1     1             0.11000             1.25000           16.00000
   2     2             0.11000             1.15000           40.00000
   3     3             0.11000             1.05000          150.0000C
   4     4             0.11000             0.95000          440.0000C
   5     5             0.11000             0.85000         1360.00000
   6     6             0.11000             0.75000         2500.0000C
   7     7             0.11000             0.65000         4500.00000
   8     8             0.11000             0.55000         6500.00000
   9     9             0.11000             0.45000         9500.C0000
  1C    1C             C.11000             0.35000        17000.0000C

BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE      TYPE
```

1	10	9	8	7	6	5	4	3	2	1
2	1	2	3	4	5	6	7	8	9	10

```
SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U166808

AKT =    2.72

RELAXATION CONSTANT C1=     10000000.00

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
FLIGHT OR BLOCK NO.    1
 STMAX    STMIN    SIGMAX    SIGMIN     RES     EQRES     ENN              NEP
 37.25     3.28    72.00    -20.40     0.0    -29.32    16.00   0.17906543E 04   1   1
 34.27     3.28    63.89    -20.40   -29.32   -21.21    40.00   0.21008384E 04   2   2
RELAXATION      ,  63.91    -20.39                        4.00                                  2
RELAXATION      ,  63.95    -20.35                        4.00                                  3
RELAXATION      ,  63.98    -20.32                        4.00                                  4
RELAXATION      ,  64.02    -20.28                        4.00                                  5
RELAXATION      ,  64.05    -20.25                        4.00                                  6
RELAXATION      ,  64.09    -20.21                        4.00                                  7
RELAXATION      ,  64.12    -20.18                        4.00                                  8
RELAXATION      ,  64.16    -20.14                        4.00                                  9
RELAXATION      ,  64.19    -20.11                        4.00                                 10
RELAXATION      ,  64.23    -20.07                        4.00                                 11
 31.29     3.28    56.14    -20.06   -28.97   -13.11   150.00   0.24992734E 04   3  12
RELAXATION      ,  56.25    -19.95                       15.00                                 12
RELAXATION      ,  56.46    -19.73                       15.00                                 13
RELAXATION      ,  56.67    -19.52                       15.00                                 14
RELAXATION      ,  56.89    -19.31                       15.00                                 15
RELAXATION      ,  57.09    -19.10                       15.00                                 16
RELAXATION      ,  57.30    -18.90                       15.00                                 17
RELAXATION      ,  57.50    -18.69                       15.00                                 18
RELAXATION      ,  57.70    -18.49                       15.00                                 19
RELAXATION      ,  57.89    -18.30                       15.00                                 20
RELAXATION      ,  58.09    -18.10                       15.00                                 21
 28.31     3.28    50.08    -18.01   -26.92    -5.00   440.00   0.30229507E 04   4  22
RELAXATION      ,  50.44    -17.65                       44.00                                 22
RELAXATION      ,  51.15    -16.94                       44.00                                 23
RELAXATION      ,  51.84    -16.25                       44.00                                 24
RELAXATION      ,  52.50    -15.58                       44.00                                 25
RELAXATION      ,  53.15    -14.94                       44.00                                 26
RELAXATION      ,  53.77    -14.32                       44.00                                 27
RELAXATION      ,  54.37    -13.72                       44.00                                 28
RELAXATION      ,  54.95    -13.14                       44.00                                 29
RELAXATION      ,  55.51    -12.58                       44.00                                 30
RELAXATION      ,  56.06    -12.03                       44.00                                 31
 25.33     3.28    48.22    -11.76   -20.68     0.0    ******   0.37305303E 04   5  32
RELAXATION      ,  49.05    -10.93                      136.00                                 32
RELAXATION      ,  50.05     -9.33                      136.00                                 33
```

```
RELAXATICN      ,  52.12   -7.86                    136.00                                  34
RELAXATICN      ,  53.47   -6.51                    136.00                                  35
RELAXATICN      ,  54.71   -5.27                    136.00                                  36
RELAXATICN      ,  55.85   -4.13                    136.00                                  37
RELAXATICN      ,  56.90   -3.08                    136.00                                  38
RELAXATICN      ,  57.87   -2.11                    136.00                                  39
RELAXATICN      ,  58.76   -1.22                    136.00                                  40
RELAXATICN      ,  59.57   -0.41                    136.00                                  41
 22.35     3.28 ,  51.86   -0.02    -8.93     0.0   ******  0.47195547E 04   6 42
RELAXATICN      ,  52.37    0.50                    25C.00                                  42
RELAXATICN      ,  53.34    1.46                    25C.00                                  43
RELAXATICN      ,  54.20    2.32                    250.00                                  44
RELAXATICN      ,  54.95    3.08                    25C.00                                  45
RELAXATICN      ,  55.62    3.75                    25C.00                                  46
RELAXATICN      ,  56.22    4.34                    25C.00                                  47
RELAXATICN      ,  56.74    4.87                    25C.00                                  48
RELAXATICN      ,  57.21    5.33                    25C.00                                  49
RELAXATICN      ,  57.62    5.74                    25C.00                                  50
RELAXATICN      ,  57.98    6.11                    25C.00                                  51
 19.37     3.28    50.05    6.28    -2.64     0.0   ******  0.61621797E 04   7 52
 16.39     3.28    44.09    8.43    -0.49     0.0   ******  0.83860000E C4   8 53
 13.41     3.28    36.39    8.83    -0.08     0.0   ******  0.12C79809E 05   9 54
 10.43     3.28    28.36    8.90    -0.01     0.0   ******  0.18907535E 05  10 55
THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM =     55

                                     SIGMA
      STEP             MAXIMUM                    MINIMUM               COUNTER K

        1            0.720000E 02           -0.2C4038E C2              16.00000
        2            0.639121E 02           -0.2C3860E 02               4.00000
        3            0.639475E 02           -0.203507E 02               4.00000
        4            0.639827E 02           -0.2C3154E C2               4.00000
        5            0.640178E 02           -0.2C2803E 02               4.00000
        6            0.640527E 02           -0.2C2454E 02               4.00000
        7            0.640875E 02           -0.2C2106E 02               4.00000
        8            0.641221E 02           -0.2C1760E 02               4.00000
        9            0.641566E 02           -0.2C1416E C2               4.00000
       10            0.641909E 02           -0.2C1073E 02               4.00000
       11            0.642251E 02           -0.2C0731E 02               4.00000
       12            0.562454E 02           -0.199471E C2              15.00000
       13            0.564616E 02           -0.197309E 02              15.00000
       14            0.566749E 02           -0.195176E 02              15.00000
       15            0.568853E 02           -0.193072E C2              15.00000
       16            0.570928E 02           -0.190997E 02              15.00000
       17            0.572974E 02           -0.188951E C2              15.00000
       18            0.574992E 02           -0.186933E 02              15.00000
```

```
 19      0.576983E 02      -0.184942E 02       15.00000
 20      0.578946E 02      -0.182979E 02       15.00000
 21      0.580882E 02      -0.181043E 02       15.00000
 22      0.504402E 02      -0.176468E 02       44.00000
 23      0.511509E 02      -0.169361E 02       44.00000
 24      0.518382E 02      -0.162488E 02       44.00000
 25      0.525028E 02      -0.155842E 02       44.00000
 26      0.531456E 02      -0.149414E 02       44.00000
 27      0.537671E 02      -0.143199E 02       44.00000
 28      0.543681E 02      -0.137188E 02       44.00000
 29      0.549494E 02      -0.131376E 02       44.00000
 30      0.555115E 02      -0.125755E 02       44.00000
 31      0.560550E 02      -0.120320E 02       44.00000
 32      0.490494E 02      -0.109320E 02      136.00000
 33      0.506478E 02      -0.933364E 01      136.00000
 34      0.521174E 02      -0.786399E 01      136.00000
 35      0.534687E 02      -0.651268E 01      136.00000
 36      0.547112E 02      -0.527019E 01      136.00000
 37      0.558536E 02      -0.412777E 01      136.00000
 38      0.569041E 02      -0.307734E 01      136.00000
 39      0.578699E 02      -0.211150E 01      136.00000
 40      0.587579E 02      -0.122344E 01      136.00000
 41      0.595745E 02      -0.406895E 00      136.00000
 42      0.523729E 02       0.497128E 00      250.00000
 43      0.533398E 02       0.146400E 01      250.00000
 44      0.541956E 02       0.231985E 01      250.00000
 45      0.549532E 02       0.307740E 01      250.00000
 46      0.556237E 02       0.374795E 01      250.00000
 47      0.562173E 02       0.434149E 01      250.00000
 48      0.567427E 02       0.486686E 01      250.00000
 49      0.572077E 02       0.533191E 01      250.00000
 50      0.576193E 02       0.574353E 01      250.00000
 51      0.579837E 02       0.610789E 01      250.00000
 52      0.500491E 02       0.627898E 01     4500.00000
 53      0.440901E 02       0.842553E 01     6500.00000
 54      0.363929E 02       0.883383E 01     9500.00000
 55      0.283561E 02       0.890269E 01     **********

                 RANGE PAIR CYCLE COUNTED SPECTRUM

                               SIGMA
STEP           MAXIMUM                      MINIMUM              COUNTER K

  1      0.720000E 02      -0.204038E 02       16.00000
  2      0.639121E 02      -0.203860E 02        4.00000
  3      0.639475E 02      -0.203507E 02        4.00000
  4      0.639827E 02      -0.203154E 02        4.00000
```

```
 5     0.640178E 02     -0.202803E 02        4.00000
 6     0.640527E 02     -0.202454E 02        4.00000
 7     0.640875E 02     -0.202106E 02        4.00000
 8     0.641221E 02     -0.201760E 02        4.00000
 9     0.641566E 02     -0.201416E 02        4.00000
10     0.641909E 02     -0.201073E 02        4.00000
11     0.642251E 02     -0.200731E 02        4.00000
12     0.562454E 02     -0.199471E 02       15.00000
13     0.564616E 02     -0.197309E 02       15.00000
14     0.566749E 02     -0.195176E 02       15.00000
15     0.568853E 02     -0.193072E 02       15.00000
16     0.570928E 02     -0.190997E 02       15.00000
17     0.572974E 02     -0.188951E 02       15.00000
18     0.574992E 02     -0.186933E 02       15.00000
19     0.576983E 02     -0.184942E 02       15.00000
20     0.578946E 02     -0.182979E 02       15.00000
21     0.580882E 02     -0.181043E 02       15.00000
22     0.504402E 02     -0.176468E 02       44.00000
23     0.511509E 02     -0.169361E 02       44.00000
24     0.518382E 02     -0.162488E 02       44.00000
25     0.525028E 02     -0.155842E 02       44.00000
26     0.531456E 02     -0.149414E 02       44.00000
27     0.537671E 02     -0.143199E 02       44.00000
28     0.543681E 02     -0.137188E 02       44.00000
29     0.549494E 02     -0.131376E 02       44.00000
30     0.555115E 02     -0.125755E 02       44.00000
31     0.560550E 02     -0.120320E 02       44.00000
32     0.490494E 02     -0.109320E 02      136.00000
33     0.506478E 02     -0.933364E 01      136.00000
34     0.521174E 02     -0.786399E 01      136.00000
35     0.534687E 02     -0.651268E 01      136.00000
36     0.547112E 02     -0.527019E 01      136.00000
37     0.558536E 02     -0.412777E 01      136.00000
38     0.569041E 02     -0.307734E 01      136.00000
39     0.578699E 02     -0.211150E 01      136.00000
40     0.587579E 02     -0.122344E 01      136.00000
41     0.595745E 02     -0.406895E 00      136.00000
42     0.523729E 02      0.497128E 00      250.00000
43     0.533398E 02      0.146400E 01      250.00000
44     0.541956E 02      0.231985E 01      250.00000
45     0.549532E 02      0.307740E 01      250.00000
46     0.556237E 02      0.374795E 01      250.00000
47     0.562173E 02      0.434149E 01      250.00000
48     0.567427E 02      0.486686E 01      250.00000
49     0.572077E 02      0.531191E 01      250.00000
50     0.576193E 02      0.574353E 01      250.00000
51     0.579837E 02      0.610789E 01      250.00000
52     0.500491E 02      0.627898E 01     4500.00000
```

```
         53             0.440901E 02            0.842553E 01            6500.00000
         54             0.363929E 02            0.883383E 01            9500.00000
         55             0.283561E 02            0.890269E 01            **********

 LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

        STEP          PLASTIC STRAIN            MAX OR MIN                   DAMAGE
          1               0.00706                  MAX                 0.603661E-03
                                   DAMAGE FROM PLASTIC STRAINS= 0.60366094E-03

      SIGMAX   SIGMIN            RNCYC            CYCLES              ENN/CYC
       72.00   -20.40              16.       0.99999805E 04   0.16000031E-02
       63.91   -20.39               4.       0.10991109E 05   0.36393036E-03
       63.95   -20.35               4.       0.10971137E 05   0.36459300E-03
       63.98   -20.32               4.       0.10951203E 05   0.36525656E-03
       64.02   -20.28               4.       0.10938156E 05   0.36569219E-03
       64.05   -20.25               4.       0.10931410E 05   0.36591780E-03
       64.09   -20.21               4.       0.10919895E 05   0.36630384E-03
       64.12   -20.18               4.       0.10897375E 05   0.36706077E-03
       64.16   -20.14               4.       0.10886496E 05   0.36742748E-03
       64.19   -20.11               4.       0.10866238E 05   0.36811247E-03
       64.23   -20.07               4.       0.10866332E 05   0.36810944E-03
       56.25   -19.95              15.       0.20582109E 05   0.72878809E-03
       56.46   -19.73              15.       0.20355750E 05   0.73689246E-03
       56.67   -19.52              15.       0.20136930E 05   0.74489997E-03
       56.89   -19.31              15.       0.19923332E 05   0.75288606E-03
       57.09   -19.10              15.       0.19717301E 05   0.76075317E-03
       57.30   -18.90              15.       0.19512488E 05   0.76873833E-03
       57.50   -18.69              15.       0.19313871E 05   0.77664386E-03
       57.70   -18.49              15.       0.19118684E 05   0.78457268E-03
       57.89   -18.30              15.       0.18930270E 05   0.79238159E-03
       58.09   -18.10              15.       0.18745156E 05   0.80020656E-03
       50.44   -17.65              44.       0.48274484E 05   0.91145444E-03
       51.15   -16.94              44.       0.46130172E 05   0.95382240E-03
       51.84   -16.25              44.       0.44135836E 05   0.99692214E-03
       52.50   -15.58              44.       0.42277648E 05   0.10407390E-02
       53.15   -14.94              44.       0.40551523E 05   0.10850392E-02
       53.77   -14.32              44.       0.38937594E 05   0.11300133E-02
       54.37   -13.72              44.       0.37430422E 05   0.11755142E-02
       54.95   -13.14              44.       0.36023273E 05   0.12214326E-02
       55.51   -12.58              44.       0.34707199E 05   0.12677484E-02
       56.06   -12.03              44.       0.33473281E 05   0.13144810E-02
       49.05   -10.93             136.       0.11033494E 06   0.12326103E-02
       50.65    -9.33             136.       0.97210188E 05   0.13990302E-02
       52.12    -7.86             136.       0.86354438E 05   0.15749044E-02
       53.47    -6.51             136.       0.77311188E 05   0.17591242E-02
       54.71    -5.27             136.       0.69733688E 05   0.19502768E-02
```

```
       55.85   -4.13        136.        0.63343938E 05  0.21470089E-02
       56.90   -3.08        136.        0.57930816E 05  0.23476277E-02
       57.87   -2.11        136.        0.53320855E 05  0.25505966E-02
       58.76   -1.22        136.        0.49367605E 05  0.27548429E-02
       59.57   -0.41        136.        0.45970492E 05  0.29584193E-02
       52.37    0.50        250.        0.20244175E 06  0.12349230E-02
       53.34    1.46        250.        0.18366988E 06  0.13611377E-02
       54.20    2.32        250.        0.16833456E 06  0.14851375E-02
       54.95    3.08        250.        0.15569025E 06  0.16057524E-02
       55.62    3.75        250.        0.14520594E 06  0.17216925E-02
       56.22    4.34        250.        0.13643463E 06  0.18323793E-02
       56.74    4.87        250.        0.12905781E 06  0.19371163E-02
       57.21    5.33        250.        0.12282413E 06  0.20354306E-02
       57.62    5.74        250.        0.11752700E 06  0.21271706E-02
       57.98    6.11        250.        0.11300669E 06  0.22122583E-02
       50.05    6.28       4500.        0.81512081E 06  0.55206530E-02
       44.09    8.43       6500.        0.77923370E 07  0.83415280E-03
       36.39    8.83       9500.        0.20005853E 09  0.47486101E-04
       28.36    8.90      17000.        0.47726305E 10  0.35619769E-05

                             DAMAGE PER THIS SET= 0.69243014E-01

                              TOTAL ENN/CYC =, 0.69243014E-01
 FLIGHT OR BLOCK NO.     2
  STMAX     STMIN     SIGMAX    SIGMIN    RES     EQRES     ENN          NEP
  37.25      3.28      72.00   -20.40   -0.01   -29.32    16.00   0.17906543E 04   1   1
  34.27      3.28      63.89   -20.40  -29.32   -21.21    40.00   0.21008384E 04   2   2
 RELAXATION       ,    63.91   -20.39                      4.00                            2
 RELAXATION       ,    63.95   -20.35                      4.00                            3
 RELAXATION       ,    63.98   -20.32                      4.00                            4
 RELAXATION       ,    64.02   -20.28                      4.00                            5
 RELAXATION       ,    64.05   -20.25                      4.00                            6
 RELAXATION       ,    64.09   -20.21                      4.00                            7
 RELAXATION       ,    64.12   -20.18                      4.00                            8
 RELAXATION       ,    64.16   -20.14                      4.00                            9
 RELAXATION       ,    64.19   -20.11                      4.00                           10
 RELAXATION       ,    64.23   -20.07                      4.00                           11
  31.29      3.28      56.14   -20.06  -28.97   -13.11   150.00   0.24992734E 04   3  12
 RELAXATION       ,    56.25   -19.95                     15.00                           12
 RELAXATION       ,    56.46   -19.73                     15.00                           13
 RELAXATION       ,    56.67   -19.52                     15.00                           14
 RELAXATION       ,    56.89   -19.31                     15.00                           15
 RELAXATION       ,    57.09   -19.10                     15.00                           16
 RELAXATION       ,    57.30   -18.90                     15.00                           17
 RELAXATION       ,    57.50   -18.69                     15.00                           18
 RELAXATION       ,    57.70   -18.49                     15.00                           19
 RELAXATION       ,    57.89   -18.30                     15.00                           20
 RELAXATION       ,    58.09   -18.10                     15.00                           21
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  28.31      3.28    50.08   -18.01   -26.92     -5.00 440.00  0.30229507E 04   4 22
RELAXATION        ,  50.44   -17.65                     44.00                              22
RELAXATION        ,  51.15   -16.94                     44.00                              23
RELAXATION        ,  51.84   -16.25                     44.00                              24
RELAXATION        ,  52.50   -15.58                     44.00                              25
RELAXATION        ,  53.15   -14.94                     44.00                              26
RELAXATION        ,  53.77   -14.32                     44.00                              27
RELAXATION        ,  54.37   -13.72                     44.00                              28
RELAXATION        ,  54.95   -13.14                     44.00                              29
RELAXATION        ,  55.51   -12.58                     44.00                              30
RELAXATION        ,  56.06   -12.03                     44.00                              31
  25.33      3.28    48.22   -11.76   -20.68      0.0  ******  0.37305303E 04   5 32
RELAXATION        ,  49.05   -10.93                    136.00                              32
RELAXATION        ,  50.65    -9.33                    136.00                              33
RELAXATION        ,  52.12    -7.86                    136.00                              34
RELAXATION        ,  53.47    -6.51                    136.00                              35
RELAXATION        ,  54.71    -5.27                    136.00                              36
RELAXATION        ,  55.85    -4.13                    136.00                              37
RELAXATION        ,  56.90    -3.08                    136.00                              38
RELAXATION        ,  57.87    -2.11                    136.00                              39
RELAXATION        ,  58.76    -1.22                    136.00                              40
RELAXATION        ,  59.57    -0.41                    136.00                              41
  22.35      3.28    51.86    -0.02    -8.93      0.0  ******  0.47195547E 04   6 42
RELAXATION        ,  52.37     0.50                    250.00                              42
RELAXATION        ,  53.34     1.46                    250.00                              43
RELAXATION        ,  54.20     2.32                    250.00                              44
RELAXATION        ,  54.95     3.08                    250.00                              45
RELAXATION        ,  55.62     3.75                    250.00                              46
RELAXATION        ,  56.22     4.34                    250.00                              47
RELAXATION        ,  56.74     4.87                    250.00                              48
RELAXATION        ,  57.21     5.33                    250.00                              49
RELAXATION        ,  57.62     5.74                    250.00                              50
RELAXATION        ,  57.98     6.11                    250.00                              51
  19.37      3.28    50.05     6.28    -2.64      0.0  ******  0.61621797E 04   7 52
  16.39      3.28    44.09     8.43    -0.49      0.0  ******  0.83860000E 04   8 53
  13.41      3.28    36.39     8.83    -0.08      0.0  ******  0.12079809E 05   9 54
  10.43      3.28    28.36     8.90    -0.01      0.0  ******  0.18907535E 05  10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

      STEP          PLASTIC STRAIN           MAX OR MIN                DAMAGE
        1              0.00706                  MAX               0.603239E-03
                                DAMAGE FROM PLASTIC STRAINS= 0.60323928E-03

     SIGMAX   SIGMIN           RNCYC            CYCLES             ENN/CYC
      72.00   -20.40            16.          0.99999805E 04   0.16000031E-02
      63.91   -20.39             4.          0.10991109E 05   0.36393036E-03
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63.95  -20.35     4.      0.10971137E 05  0.36459300E-03
63.98  -20.32     4.      0.10951203E 05  0.36525656E-03
64.02  -20.28     4.      0.10938156E 05  0.36569219E-03
64.05  -20.25     4.      0.10931410E 05  0.36591780E-03
64.09  -20.21     4.      0.10919895E 05  0.36630384E-03
64.12  -20.18     4.      0.10897375E 05  0.36706077E-03
64.16  -20.14     4.      0.10886496E 05  0.36742748E-03
64.19  -20.11     4.      0.10866238E 05  0.36811247E-03
64.23  -20.07     4.      0.10866332E 05  0.36810944E-03
56.25  -19.95    15.      0.20582109E 05  0.72878809E-03
56.46  -19.73    15.      0.20355750E 05  0.73689246E-03
56.67  -19.52    15.      0.20136930E 05  0.74489997E-03
56.89  -19.31    15.      0.19923332E 05  0.75288606E-03
57.09  -19.10    15.      0.19717301E 05  0.76075317E-03
57.30  -18.90    15.      0.19512488E 05  0.76873833E-03
57.50  -18.69    15.      0.19313871E 05  0.77664386E-03
57.70  -18.49    15.      0.19118684E 05  0.78457268E-03
57.89  -18.30    15.      0.18930270E 05  0.79238159E-03
58.09  -18.10    15.      0.18745156E 05  0.80020656E-03
50.44  -17.65    44.      0.48274484E 05  0.91145444E-03
51.15  -16.94    44.      0.46130172E 05  0.95382240E-03
51.84  -16.25    44.      0.44135836E 05  0.99692214E-03
52.50  -15.58    44.      0.42277648E 05  0.10407390E-02
53.15  -14.94    44.      0.40551523E 05  0.10850392E-02
53.77  -14.32    44.      0.38937594E 05  0.11300133E-02
54.37  -13.72    44.      0.37430422E 05  0.11755142E-02
54.95  -13.14    44.      0.36023273E 05  0.12214326E-02
55.51  -12.58    44.      0.34707199E 05  0.12677484E-02
56.06  -12.03    44.      0.33473281E 05  0.13144810E-02
49.05  -10.93   136.      0.11033494E 06  0.12326103E-02
50.65   -9.33   136.      0.97210188E 05  0.13990302E-02
52.12   -7.86   136.      0.86354438E 05  0.15749044E-02
53.47   -6.51   136.      0.77311188E 05  0.17591242E-02
54.71   -5.27   136.      0.69733688E 05  0.19502768E-02
55.85   -4.13   136.      0.63343938E 05  0.21470089E-02
56.90   -3.08   136.      0.57930816E 05  0.23476277E-02
57.87   -2.11   136.      0.53320855E 05  0.25505966E-02
58.76   -1.22   136.      0.49367605E 05  0.27548429E-02
59.57   -0.41   136.      0.45970492E 05  0.29584193E-02
52.37    0.50   250.      0.20244175E 06  0.12349230E-02
53.34    1.46   250.      0.18366988E 06  0.13611377E-02
54.20    2.32   250.      0.16833456E 06  0.14851375E-02
54.95    3.08   250.      0.15569025E 06  0.16057524E-02
55.62    3.75   250.      0.14520594E 06  0.17216925E-02
56.22    4.34   250.      0.13643463E 06  0.18323793E-02
56.74    4.87   250.      0.12905781E 06  0.19371163E-02
57.21    5.33   250.      0.12282413E 06  0.20354306E-02
57.62    5.74   250.      0.11752700E 06  0.21271706E-02
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57.98     6.11          250.        0.11300669E 06  0.22122583E-02
50.05     6.28         4500.        0.81512081E 06  0.55206530E-02
44.09     8.43         6500.        0.77923370E 07  0.83415280E-03
36.39     8.83         9500.        0.20005853E 09  0.47486101E-04
28.36     8.90        17000.        0.47726305E 10  0.35619769E-05
                               DAMAGE PER THIS SET= 0.69242597E-01
                                TOTAL ENN/CYC =, 0.13848418E 00
```

```
INPUT OF BLOCK LOADS



   1   1   2
A7 CRITICAL POINT #1 FROM U166808
7075-T6 AL                     72.              0.4            -1.836    10000.
            -.0020             .2801             71.7MIL-HDBK-5A      4 7075
            -.0022             .5154             56.3MIL-HDBK-5A      5 7075
            -.0014             .6141             44.6MIL-HDBK-5A      6 7075
            -.0013             .6838             38.1MIL-HDBK-5A      7 7075
         10000000.                1.                1.
              2.72
         2        10        10
              29.8
   1     1                 .11              1.25                16.
   2     2                 .11              1.15                40.
   3     3                 .11              1.05               150.
   4     4                 .11               .95               440.
   5     5                 .11               .85              1360.
   6     6                 .11               .75              2500.
   7     7                 .11               .65              4500.
   8     8                 .11               .55              6500.
   9     9                 .11               .45              9500.
  10    10                 .11               .35             17000.
    1   10    9    8    7    6    5    4    3    2    1
    2    1    2    3    4    5    6    7    8    9   10
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OUTPLT CF BLOCK LOADS, IPRINT = 1



   1 CATA DECKS ARE TO BE PROCESSED.
NO CCUNTING METHODS USED
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
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SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U166808
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --          72.00000

LCF STRAIN INTERCEPT =             0.40000

INVERSE OF COFFIN-MANSON SLOPE          -1.83600

ELASTIC MODULUS =        10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE              A(I)              B(I)              C(I)
   10** 4           -0.00200           0.28010          71.70000
   10** 5           -0.00220           0.51540          56.29999
   10** 6           -0.00140           0.61410          44.59999
   10** 7           -0.00130           0.68380          38.09999

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  MIL-HDBK-5A

RESIDUAL STRESS RELAXATION FUNCTION

    ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = 0.10000000E 08 ,   E1 =     1.000 AND  E2 =      1.000

      2 TIMES THROUGH BLOCK OF        10 LOADS

     LOAD LIMIT =          29.79999

STEP  TYPE            STMIN             STMAX              ENN
  1     1            0.11000           1.25000           16.00000
  2     2            0.11000           1.15000           40.00000
  3     3            0.11000           1.05000          150.00000
  4     4            0.11000           0.95000          440.00000
  5     5            0.11000           0.85000         1360.00000
  6     6            0.11000           0.75000         2500.00000
  7     7            0.11000           0.65000         4500.00000
  8     8            0.11000           0.55000         6500.00000
  9     9            0.11000           0.45000         9500.00000
 10    10            0.11000           0.35000        17000.00000

BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE      TYPE
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1	10	9	8	7	6	5	4	3	2	1
2	1	2	3	4	5	6	7	8	9	10

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SPECTRUM FRCM  A7 CRITICAL PCINT #1 FROM U166808

AKT =    2.72

RELAXATICN CONSTANT C1=     10000000.00
FLIGHT CR BLOCK NO.    1
 STMAX    STMIN    SIGMAX    SIGMIN    RES     EQRES     ENN              NEP
 37.25     3.28    72.00    -20.40     0.0    -29.32    16.00   0.17906543E 04   1  1
 34.27     3.28    63.89    -20.40   -29.32   -21.21    4C.CO   0.21008384E 04   2  2
RELAXATICN       ,  63.91    -20.39                        4.00                             2
RELAXATICN       ,  63.95    -20.35                        4.00                             3
RELAXATICN       ,  63.98    -20.32                        4.00                             4
RELAXATICN       ,  64.02    -20.28                        4.00                             5
RELAXATICN       ,  64.05    -20.25                        4.00                             6
RELAXATICN       ,  64.09    -20.21                        4.00                             7
RELAXATICN       ,  64.12    -20.18                        4.00                             8
RELAXATICN       ,  64.16    -20.14                        4.00                             9
RELAXATICN       ,  64.19    -20.11                        4.00                            10
RELAXATICN       ,  64.23    -20.07                        4.00                            11
 31.29     3.28    56.14    -20.06   -28.97   -13.11  15C.00   C.24992734E 04   3 12
RELAXATICN       ,  56.25    -19.95                       15.CO                            12
RELAXATICN       ,  56.46    -19.73                       15.00                            13
RELAXATICN       ,  56.67    -19.52                       15.00                            14
RELAXATICN       ,  56.89    -19.31                       15.00                            15
RELAXATICN       ,  57.09    -19.10                       15.00                            16
RELAXATICN       ,  57.30    -18.90                       15.00                            17
RELAXATICN       ,  57.50    -18.69                       15.CO                            18
RELAXATICN       ,  57.70    -18.49                       15.00                            19
RELAXATICN       ,  57.89    -18.30                       15.00                            20
RELAXATICN       ,  58.09    -18.10                       15.00                            21
 28.31     3.28    50.08    -18.01   -26.92    -5.00  44C.00   0.30229507E 04   4 22
RELAXATICN       ,  50.44    -17.65                       44.00                            22
RELAXATICN       ,  51.15    -16.94                       44.00                            23
RELAXATICN       ,  51.84    -16.25                       44.00                            24
RELAXATICN       ,  52.50    -15.58                       44.00                            25
RELAXATICN       ,  53.15    -14.94                       44.00                            26
RELAXATICN       ,  53.77    -14.32                       44.CO                            27
RELAXATICN       ,  54.37    -13.72                       44.00                            28
RELAXATICN       ,  54.95    -13.14                       44.00                            29
RELAXATICN       ,  55.51    -12.58                       44.00                            30
RELAXATICN       ,  56.06    -12.03                       44.00                            31
 25.33     3.28    48.22    -11.76   -20.68     0.0   ******   0.37305303E 04   5 32
RELAXATICN       ,  49.05    -10.93                      136.00                            32
RELAXATICN       ,  50.65     -9.33                      136.00                            33
RELAXATICN       ,  52.12     -7.86                      136.00                            34
RELAXATICN       ,  53.47     -6.51                      136.00                            35
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RELAXATICN     ,  54.71   -5.27                    136.C0                          36
RELAXATICN     ,  55.85   -4.13                    136.00                          37
RELAXATICN     ,  56.90   -3.08                    136.00                          38
RELAXATICN     ,  57.87   -2.11                    136.00                          39
RELAXATICN     ,  58.76   -1.22                    136.00                          40
RELAXATICN     ,  59.57   -0.41                    136.00                          41
 22.35     3.28   51.86   -0.02    -8.93     0.0   ******  0.47195547E 04  6 42
RELAXATICN     ,  52.37    C.50                    25C.00                          42
RELAXATICN     ,  53.34    1.46                    25C.00                          43
RELAXATICN     ,  54.20    2.32                    25C.00                          44
RELAXATICN     ,  54.95    3.08                    25C.00                          45
RELAXATICN     ,  55.62    3.75                    25C.0C                          46
RELAXATICN     ,  56.22    4.34                    25C.00                          47
RELAXATICN     ,  56.74    4.87                    25C.00                          48
RELAXATICN     ,  57.21    5.33                    25C.0C                          49
RELAXATICN     ,  57.62    5.74                    25C.00                          50
RELAXATICN     ,  57.98    6.11                    25C.0C                          51
 19.37     3.28   50.05    6.28    -2.64     0.0   ******  0.61621797E 04  7 52
 16.39     3.28   44.09    8.43    -0.49     0.0   ******  0.83860000E 04  8 53
 13.41     3.28   36.39    8.83    -0.08     0.0   ******  0.12C79809E C5  9 54
 10.43     3.28   28.36    8.90    -0.01     0.0   ******  0.18907535E C5 10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

     STEP          PLASTIC STRAIN          MAX CR MIN                DAMAGE
      1               0.00706                 MAX              0.603661E-03
                                   DAMAGE FROM PLASTIC STRAINS= 0.60366094E-03

     SIGMAX   SIGMIN          RNCYC         CYCLES             ENN/CYC
     72.00   -20.40            16.      0.99999805E 04   0.16000031E-02
     63.91   -20.39             4.      0.10991109E 05   C.36393036E-03
     63.95   -20.35             4.      0.10971137E 05   C.36459300E-03
     63.98   -20.32             4.      0.10951203E C5   C.36525656E-03
     64.02   -20.28             4.      0.10938156E 05   C.36569219E-03
     64.05   -20.25             4.      0.10931410E 05   C.36591780E-03
     64.09   -20.21             4.      0.10919895E 05   C.36630384E-03
     64.12   -20.18             4.      0.10897375E 05   C.36706077E-03
     64.16   -20.14             4.      0.10886496E 05   0.36742748E-03
     64.19   -20.11             4.      0.10866238E 05   C.36811247E-03
     64.23   -20.07             4.      0.10866332E 05   C.36810944E-03
     56.25   -19.95            15.      0.20582109E 05   C.72878809E-03
     56.46   -19.73            15.      0.20355750E 05   0.73689246E-03
     56.67   -19.52            15.      0.20136930E 05   0.74489997E-03
     56.89   -19.31            15.      0.19923332E 05   C.75288606E-C3
     57.09   -19.10            15.      0.19717301E C5   0.76075317E-03
     57.30   -18.90            15.      0.19512488E 05   0.76873833E-03
     57.50   -18.69            15.      0.19313871E C5   0.77664386E-03
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    57.70  -18.49          15.        0.19118684E 05  0.78457268E-03
    57.89  -18.30          15.        0.18930270E 05  0.79238159E-03
    58.09  -18.10          15.        0.18745156E 05  0.80020656E-03
    50.44  -17.65          44.        0.48274484E 05  0.91145444E-03
    51.15  -16.94          44.        0.46130172E 05  0.95382240E-03
    51.84  -16.25          44.        0.44135836E 05  0.99692214E-03
    52.50  -15.58          44.        0.42277648E 05  0.10407390E-02
    53.15  -14.94          44.        0.40551523E 05  0.10850392E-02
    53.77  -14.32          44.        0.38937594E 05  0.11300133E-02
    54.37  -13.72          44.        0.37430422E 05  0.11755142E-02
    54.95  -13.14          44.        0.36023273E 05  0.12214326E-02
    55.51  -12.58          44.        0.34707199E 05  0.12677484E-02
    56.06  -12.03          44.        0.33473281E 05  0.13144810E-02
    49.05  -10.93         136.        0.11033494E 06  0.12326103E-02
    50.65   -9.33         136.        0.97210188E 05  0.13990302E-02
    52.12   -7.86         136.        0.86354438E 05  0.15749044E-02
    53.47   -6.51         136.        0.77311188E 05  0.17591242E-02
    54.71   -5.27         136.        0.69733688E 05  0.19502768E-02
    55.85   -4.13         136.        0.63343938E 05  0.21470089E-02
    56.90   -3.08         136.        0.57930816E 05  0.23476277E-02
    57.87   -2.11         136.        0.53320855E 05  0.25505966E-02
    58.76   -1.22         136.        0.49367605E 05  0.27548429E-02
    59.57   -0.41         136.        0.45970492E 05  0.29584193E-02
    52.37    0.50         250.        0.20244175E 06  0.12349230E-02
    53.34    1.46         250.        0.18366988E 06  0.13611377E-02
    54.20    2.32         250.        0.16833456E 06  0.14851375E-02
    54.95    3.08         250.        0.15569025E 06  0.16057524E-02
    55.62    3.75         250.        0.14520594E 06  0.17216925E-02
    56.22    4.34         250.        0.13643463E 06  0.18323793E-02
    56.74    4.87         250.        0.12905781E 06  0.19371163E-02
    57.21    5.33         250.        0.12282413E 06  0.20354306E-02
    57.62    5.74         250.        0.11752700E 06  0.21271706E-02
    57.98    6.11         250.        0.11300669E 06  0.22122583E-02
    50.05    6.28        4500.        0.81512081E 06  0.55206530E-02
    44.09    8.43        6500.        0.77923370E 07  0.83415280E-03
    36.39    8.83        9500.        0.20005853E 09  0.47486101E-04
    28.36    8.90       17000.        0.47726305E 10  0.35619769E-05

                             DAMAGE PER THIS SET= 0.69243014E-01

                              TOTAL ENN/CYC =, 0.69243014E-01
FLIGHT OF BLOCK NO.     2
 STMAX   STMIN   SIGMAX   SIGMIN    RES    EQRES   ENN           NEP
 37.25    3.28   72.00   -20.40   -0.01  -29.32  16.00  0.17906543E 04  1  1
 34.27    3.28   63.89   -20.40  -29.32  -21.21  40.00  0.21008384E 04  2  2
RELAXATION     ,  63.91  -20.39                   4.00                       2
RELAXATION     ;  63.95  -20.35                   4.00                       3
RELAXATION     ,  63.98  -20.32                   4.00                       4
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RELAXATICN     ,  64.02  -20.28                         4.00                          5
RELAXATICN     ,  64.05  -20.25                         4.00                          6
RELAXATICN     ,  64.09  -20.21                         4.00                          7
RELAXATICN     ,  64.12  -20.18                         4.00                          8
RELAXATICN     ,  64.16  -20.14                         4.00                          9
RELAXATICN     ,  64.19  -20.11                         4.00                         10
RELAXATICN     ,  64.23  -20.07                         4.00                         11
 31.29     3.28   56.14  -20.06   -28.97  -13.11 15C.00  0.24992734E 04  3 12
RELAXATICN     ,  56.25  -19.95                        15.00                         12
RELAXATICN     ,  56.46  -19.73                        15.00                         13
RELAXATICN     ,  56.67  -19.52                        15.00                         14
RELAXATICN     ,  56.89  -19.31                        15.00                         15
RELAXATICN     ,  57.09  -19.10                        15.00                         16
RELAXATICN     ,  57.30  -18.90                        15.00                         17
RELAXATICN     ,  57.50  -18.69                        15.00                         18
RELAXATICN     ,  57.70  -18.49                        15.00                         19
RELAXATICN     ,  57.89  -18.30                        15.00                         20
RELAXATICN     ,  58.09  -18.10                        15.00                         21
 28.31     3.28   50.08  -18.01   -26.92   -5.00 44C.00  0.30229507E 04  4 22
RELAXATICN     ,  50.44  -17.65                        44.00                         22
RELAXATICN     ,  51.15  -16.94                        44.00                         23
RELAXATICN     ,  51.84  -16.25                        44.00                         24
RELAXATICN     ,  52.50  -15.58                        44.00                         25
RELAXATICN     ,  53.15  -14.94                        44.00                         26
RELAXATICN     ,  53.77  -14.32                        44.00                         27
RELAXATICN     ,  54.37  -13.72                        44.00                         28
RELAXATICN     ,  54.95  -13.14                        44.00                         29
RELAXATICN     ,  55.51  -12.56                        44.00                         30
RELAXATICN     ,  56.06  -12.03                        44.00                         31
 25.33     3.28   48.22  -11.76   -20.68    0.0  ******  0.37305303E 04  5 32
RELAXATICN     ,  49.05  -10.93                       136.00                         32
RELAXATICN     ,  50.65   -9.33                       136.00                         33
RELAXATICN     ,  52.12   -7.86                       136.00                         34
RELAXATICN     ,  53.47   -6.51                       136.00                         35
RELAXATICN     ,  54.71   -5.27                       136.00                         36
RELAXATICN     ,  55.85   -4.13                       136.00                         37
RELAXATICN     ,  56.90   -3.08                       136.00                         38
RELAXATICN     ,  57.87   -2.11                       136.00                         39
RELAXATICN     ,  58.76   -1.22                       136.00                         40
RELAXATICN     ,  59.57   -0.41                       136.00                         41
 22.35     3.28   51.86   -0.02    -8.93    0.0  ******  0.47195547E 04  6 42
RELAXATICN     ,  52.37    0.50                       25C.00                         42
RELAXATICN     ,  53.34    1.46                       25C.00                         43
RELAXATICN     ,  54.20    2.32                       25C.00                         44
RELAXATICN     ,  54.95    3.08                       25C.00                         45
RELAXATICN     ,  55.62    3.75                       25C.00                         46
RELAXATICN     ,  56.22    4.34                       25C.00                         47
RELAXATICN     ,  56.74    4.87                       25C.00                         48
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RELAXATION  ,  57.21   5.33                    250.00                           49
RELAXATION  ,  57.62   5.74                    250.00                           50
RELAXATION  ,  57.98   6.11                    250.00                           51
 19.37   3.28  50.05   6.28   -2.64     0.0    ******   0.61621797E 04   7 52
 16.39   3.28  44.09   8.43   -0.49     0.0    ******   0.83860000E 04   8 53
 13.41   3.28  36.39   8.83   -0.08     0.0    ******   0.12079809E 05   9 54
 10.43   3.28  28.36   8.90   -0.01     0.0    ******   0.18907535E 05  10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

      STEP          PLASTIC STRAIN         MAX CR MIN               DAMAGE
         1              0.00706              MAX              0.603239E-03
                              DAMAGE FROM PLASTIC STRAINS= 0.60323928E-03

      SIGMAX  SIGMIN           RNCYC         CYCLES            ENN/CYC
       72.00  -20.40            16.       0.99999805E 04   0.16000031E-02
       63.91  -20.39             4.       0.10991109E 05   0.36393036E-03
       63.95  -20.35             4.       0.10971137E 05   0.36459300E-03
       63.98  -20.32             4.       0.10951203E 05   0.36525656E-03
       64.02  -20.28             4.       0.10938156E 05   0.36569219E-03
       64.05  -20.25             4.       0.10931410E 05   0.36591780E-03
       64.09  -20.21             4.       0.10919895E 05   0.36630384E-03
       64.12  -20.18             4.       0.10897375E 05   0.36706077E-03
       64.16  -20.14             4.       0.10886496E 05   0.36742748E-03
       64.19  -20.11             4.       0.10866238E 05   0.36811247E-03
       64.23  -20.07             4.       0.10866332E 05   0.36810944E-03
       56.25  -19.95            15.       0.20582109E 05   0.72878809E-03
       56.46  -19.73            15.       0.20355750E 05   0.73689246E-03
       56.67  -19.52            15.       0.20136930E 05   0.74489997E-03
       56.89  -19.31            15.       0.19923332E 05   0.75288606E-03
       57.09  -19.10            15.       0.19717301E 05   0.76075317E-03
       57.30  -18.90            15.       0.19512488E 05   0.76873833E-03
       57.50  -18.69            15.       0.19313871E 05   0.77664386E-03
       57.70  -18.49            15.       0.19118684E 05   0.78457268E-03
       57.89  -18.30            15.       0.18930270E 05   0.79238159E-03
       58.09  -18.10            15.       0.18745156E 05   0.80020656E-03
       50.44  -17.65            44.       0.48274484E 05   0.91145444E-03
       51.15  -16.94            44.       0.46130172E 05   0.95382240E-03
       51.84  -16.25            44.       0.44135836E 05   0.99692214E-03
       52.50  -15.58            44.       0.42277648E 05   0.10407390E-02
       53.15  -14.94            44.       0.40551523E 05   0.10850392E-02
       53.77  -14.32            44.       0.38937594E 05   0.11300133E-02
       54.37  -13.72            44.       0.37430422E 05   0.11755142E-02
       54.95  -13.14            44.       0.36023273E 05   0.12214326E-02
       55.51  -12.58            44.       0.34707199E 05   0.12677484E-02
       56.06  -12.03            44.       0.33473281E 05   0.13144810E-02
       49.05  -10.93           136.       0.11033494E 06   0.12326103E-02
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50.65    -9.33        136.        0.97210188E 05  0.13990302E-02
52.12    -7.86        136.        0.86354438E 05  0.15749044E-02
53.47    -6.51        136.        0.77311188E 05  0.17591242E-02
54.71    -5.27        136.        0.69733688E 05  0.19502768E-02
55.85    -4.13        136.        0.63343938E 05  0.21470089E-02
56.90    -3.08        136.        0.57930816E 05  0.23476277E-02
57.87    -2.11        136.        0.53320855E 05  0.25505966E-02
58.76    -1.22        136.        0.49367605E 05  0.27548429E-02
59.57    -0.41        136.        0.45970492E 05  0.29584193E-02
52.37     0.50        250.        0.20244175E 06  0.12349230E-02
53.34     1.46        250.        0.18366988E 06  0.13611377E-02
54.20     2.32        250.        0.16833456E 06  0.14851375E-02
54.95     3.08        250.        0.15569025E 06  0.16057524E-02
55.62     3.75        250.        0.14520594E 06  0.17216925E-02
56.22     4.34        250.        0.13643463E 06  0.18323793E-02
56.74     4.87        250.        0.12905781E 06  0.19371163E-02
57.21     5.33        250.        0.12282413E 06  0.20354306E-02
57.62     5.74        250.        0.11752700E 06  0.21271706E-02
57.98     6.11        250.        0.11300669E 06  0.22122583E-02
50.05     6.28       4500.        0.81512081E 06  0.55206530E-02
44.09     8.43       6500.        0.77923370E 07  0.83415280E-03
36.39     8.83       9500.        0.20005853E 09  0.47486101E-04
28.36     8.90      17000.        0.47726305E 10  0.35619769E-05

                         DAMAGE PER THIS SET= 0.69242597E-01

                          TOTAL ENN/CYC =, 0.13848418E 00
```

INPUT CF BLOCK LCADS

```
   1   2   1.
A7 CRITICAL PCINT #1 FRCM U166808
7075-T6 AL                     72.               C.4            -1.836    10000.
            -.0020             .2801              71.7MIL-HCBK-5A      4 7075
            -.0022             .5154              56.3MIL-HCBK-5A      5 7075
            -.0014             .6141              44.6MIL-HDBK-5A      6 7075
            -.0013             .6838              38.1MIL-HDBK-5A      7 7075
         10C00000.                1.                1.
              2.72
         2        10         10
              29.8
   1     1                 .11              1.25               16.
   2     2                 .11              1.15               40.
   3     3                 .11              1.05              150.
   4     4                 .11               .95              440.
   5     5                 .11               .85             1360.
   6     6                 .11               .75             2500.
   7     7                 .11               .65             4500.
   8     8                 .11               .55             6500.
   9     9                 .11               .45             9500.
  10    10                 .11               .35            17000.
    1   1C    9    8    7    6    5    4    3    2    1
    2    1    2    3    4    5    6    7    8    9   10
```

```
OUTPUT OF BLOCK LOADS, IPRINT = 2



   1 DATA DECKS ARE TO BE PROCESSED.

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U1668C8
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --          72.00000

LCF STRAIN INTERCEPT =           0.40000

INVERSE OF COFFIN-MANSON SLOPE          -1.83600

ELASTIC MODULUS =        10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE              A(I)                B(I)               C(I)
   10** 4           -0.00200            0.28010           71.70000
   10** 5           -0.00220            0.51540           56.29999
   10** 6           -0.00140            0.61410           44.59999
   10** 7           -0.00130            0.68380           38.09999

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  MIL-HDBK-5A

RESIDUAL STRESS RELAXATION FUNCTION

    ENEF = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = 0.10000000E 08 ,   E1 =     1.000 AND  E2 =     1.000


      2 TIMES THROUGH BLOCK OF        10 LOADS

     LOAD LIMIT =          29.79999


STEP  TYPE            STMIN               STMAX              ENN
   1     1           0.11000             1.25000           16.00000
   2     2           0.11000             1.15000           40.00000
   3     3           0.11000             1.05000          150.00000
   4     4           0.11000             0.95000          440.00000
   5     5           0.11000             0.85000         1360.00000
   6     6           0.11000             0.75000         2500.00000
   7     7           0.11000             0.65000         4500.00000
   8     8           0.11000             0.55000         6500.00000
   9     9           0.11000             0.45000         9500.00000
  10    10           0.11000             0.35000        17000.00000


BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE      TYPE
```

```
1  1C  9  8  7  6  5  4  3  2   1
2   1  2  3  4  5  6  7  8  9  10
```

```
SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U166808

AKT =   2.72

RELAXATION CONSTANT C1=    10000000.00

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
FLIGHT OR BLOCK NO.     1
 STMAX    STMIN    SIGMAX    SIGMIN    RES     EQRES     ENN              NEP
 37.25     3.28    72.00   -20.40     0.0    -29.32    16.00   0.17906543E 04   1  1
 34.27     3.28    63.89   -20.40   -29.32   -21.21    40.00   0.21008384E 04   2  2
RELAXATION     ,   63.91   -20.39                       4.00                          2
RELAXATION     ,   63.95   -20.35                       4.00                          3
RELAXATION     ,   63.98   -20.32                       4.00                          4
RELAXATION     ,   64.02   -20.28                       4.00                          5
RELAXATION     ,   64.05   -20.25                       4.00                          6
RELAXATION     ,   64.09   -20.21                       4.00                          7
RELAXATION     ,   64.12   -20.18                       4.00                          8
RELAXATION     ,   64.16   -20.14                       4.00                          9
RELAXATION     ,   64.19   -20.11                       4.00                         10
RELAXATION     ,   64.23   -20.07                       4.00                         11
 31.29     3.28    56.14   -20.06   -28.97   -13.11   150.00   0.24992734E 04   3 12
RELAXATION     ,   56.25   -19.95                      15.00                         12
RELAXATION     ,   56.46   -19.73                      15.00                         13
RELAXATION     ,   56.67   -19.52                      15.00                         14
RELAXATION     ,   56.89   -19.31                      15.00                         15
RELAXATION     ,   57.09   -19.10                      15.00                         16
RELAXATION     ,   57.30   -18.90                      15.00                         17
RELAXATION     ,   57.50   -18.69                      15.00                         18
RELAXATION     ,   57.70   -18.49                      15.00                         19
RELAXATION     ,   57.89   -18.30                      15.00                         20
RELAXATION     ,   58.09   -18.10                      15.00                         21
 28.31     3.28    50.08   -18.01   -26.92    -5.00   440.00   0.30229507E 04   4 22
RELAXATION     ,   50.44   -17.65                      44.00                         22
RELAXATION     ,   51.15   -16.94                      44.00                         23
RELAXATION     ,   51.84   -16.25                      44.00                         24
RELAXATION     ,   52.50   -15.58                      44.00                         25
RELAXATION     ,   53.15   -14.94                      44.00                         26
RELAXATION     ,   53.77   -14.32                      44.00                         27
RELAXATION     ,   54.37   -13.72                      44.00                         28
RELAXATION     ,   54.95   -13.14                      44.00                         29
RELAXATION     ,   55.51   -12.58                      44.00                         30
RELAXATION     ,   56.06   -12.03                      44.00                         31
 25.33     3.28    48.22   -11.76   -20.68     0.0    ******   0.37305303E 04   5 32
RELAXATION     ,   49.05   -10.93                     136.00                         32
RELAXATION     ,   50.65    -9.33                     136.00                         33
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RELAXATION       ,  52.12   -7.86                        136.00                          34
RELAXATION       ,  53.47   -6.51                        136.00                          35
RELAXATION       ,  54.71   -5.27                        136.00                          36
RELAXATION       ,  55.85   -4.13                        136.00                          37
RELAXATION       ,  56.90   -3.08                        136.00                          38
RELAXATION       ,  57.87   -2.11                        136.00                          39
RELAXATION       ,  58.76   -1.22                        136.00                          40
RELAXATION       ,  59.57   -0.41                        136.00                          41
 22.35      3.28    51.86   -0.02   -8.93      0.0       ******   0.47195547E 04  6 42
RELAXATION       ,  52.37    0.50                        250.00                          42
RELAXATION       ,  53.34    1.46                        250.00                          43
RELAXATION       ,  54.20    2.32                        250.00                          44
RELAXATION       ,  54.95    3.08                        250.00                          45
RELAXATION       ,  55.62    3.75                        250.00                          46
RELAXATION       ,  56.22    4.34                        250.00                          47
RELAXATION       ,  56.74    4.87                        250.00                          48
RELAXATION       ,  57.21    5.33                        250.00                          49
RELAXATION       ,  57.62    5.74                        250.00                          50
RELAXATION       ,  57.98    6.11                        250.00                          51
 19.37      3.28    50.05    6.28   -2.64      0.0       ******   0.61621797E 04  7 52
 16.39      3.28    44.09    8.43   -0.49      0.0       ******   0.83860000E 04  8 53
 13.41      3.28    36.39    8.83   -0.08      0.0       ******   0.12079809E 05  9 54
 10.43      3.28    28.36    8.90   -0.01      0.0       ******   0.18907535E 05 10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

      STEP          PLASTIC STRAIN          MAX OR MIN                DAMAGE
        1               0.00706                MAX               0.603661E-03
                                DAMAGE FROM PLASTIC STRAINS= 0.60366094E-03

     SIGMAX   SIGMIN            RNCYC          CYCLES            ENN/CYC
      72.00   -20.40             16.       0.99999805E 04   0.16000031E-02
      63.91   -20.39              4.       0.10991109E 05   0.36393036E-03
      63.95   -20.35              4.       0.10971137E 05   0.36459300E-03
      63.98   -20.32              4.       0.10951203E 05   0.36525656E-03
      64.02   -20.28              4.       0.10938156E 05   0.36569219E-03
      64.05   -20.25              4.       0.10931410E 05   0.36591780E-03
      64.09   -20.21              4.       0.10919895E 05   0.36630384E-03
      64.12   -20.18              4.       0.10897375E 05   0.36706077E-03
      64.16   -20.14              4.       0.10886496E 05   0.36742748E-03
      64.19   -20.11              4.       0.10866238E 05   0.36811247E-03
      64.23   -20.07              4.       0.10866332E 05   0.36810944E-03
      56.25   -19.95             15.       0.20582109E 05   0.72878809E-03
      56.46   -19.73             15.       0.20355750E 05   0.73689246E-03
      56.67   -19.52             15.       0.20136930E 05   0.74489997E-03
      56.89   -19.31             15.       0.19923332E 05   0.75288606E-03
      57.09   -19.10             15.       0.19717301E 05   0.76075317E-03
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 57.30  -18.90        15.       0.19512488E 05  0.76873833E-03
 57.50  -18.69        15.       0.19313871E 05  0.77664386E-03
 57.70  -18.49        15.       0.19118684E 05  0.78457268E-03
 57.89  -18.30        15.       0.18930270E 05  0.79238159E-03
 58.09  -18.10        15.       0.18745156E 05  0.80020656E-03
 50.44  -17.65        44.       0.48274484E 05  0.91145444E-03
 51.15  -16.94        44.       0.46130172E 05  0.95382240E-03
 51.84  -16.25        44.       0.44135836E 05  0.99692214E-03
 52.50  -15.58        44.       0.42277648E 05  0.10407390E-02
 53.15  -14.94        44.       0.40551523E 05  0.10850392E-02
 53.77  -14.32        44.       0.38937594E 05  0.11300133E-02
 54.37  -13.72        44.       0.37430422E 05  0.11755142E-02
 54.95  -13.14        44.       0.36023273E 05  0.12214326E-02
 55.51  -12.58        44.       0.34707199E 05  0.12677484E-02
 56.06  -12.03        44.       0.33473281E 05  0.13144810E-02
 49.05  -10.93       136.       0.11033494E 06  0.12326103E-02
 50.65   -9.33       136.       0.97210188E 05  0.13990302E-02
 52.12   -7.86       136.       0.86354438E 05  0.15749044E-02
 53.47   -6.51       136.       0.77311188E 05  0.17591242E-02
 54.71   -5.27       136.       0.69733688E 05  0.19502768E-02
 55.85   -4.13       136.       0.63343938E 05  0.21470089E-02
 56.90   -3.08       136.       0.57930816E 05  0.23476277E-02
 57.87   -2.11       136.       0.53320855E 05  0.25505966E-02
 58.76   -1.22       136.       0.49367605E 05  0.27548429E-02
 59.57   -0.41       136.       0.45970492E 05  0.29584193E-02
 52.37    0.50       250.       0.20244175E 06  0.12349230E-02
 53.34    1.46       250.       0.18366988E 06  0.13611377E-02
 54.20    2.32       250.       0.16833456E 06  0.14851375E-02
 54.95    3.08       250.       0.15569025E 06  0.16057524E-02
 55.62    3.75       250.       0.14520594E 06  0.17216925E-02
 56.22    4.34       250.       0.13643463E 06  0.18323793E-02
 56.74    4.87       250.       0.12905781E 06  0.19371163E-02
 57.21    5.33       250.       0.12282413E 06  0.20354306E-02
 57.62    5.74       250.       0.11752700E 06  0.21271706E-02
 57.98    6.11       250.       0.11300669E 06  0.22122583E-02
 50.05    6.28      4500.       0.81512081E 06  0.55206530E-02
 44.09    8.43      6500.       0.77923370E 07  0.83415280E-03
 36.39    8.83      9500.       0.20005853E 09  0.47486101E-04
 28.36    8.90     17000.       0.47726305E 10  0.35619769E-05
                       DAMAGE PER THIS SET= 0.69243014E-01
                        TOTAL ENN/CYC =, 0.69243014E-01
FLIGHT CR BLOCK NO.    2
 STMAX    STMIN    SIGMAX    SIGMIN    RES     EQRES    ENN              NEP
 37.25     3.28    72.00   -20.40    -0.01   -29.32   16.00   0.17906543E 04   1   1
 34.27     3.28    63.89   -20.40   -29.32   -21.21   40.00   0.21008384E 04   2   2
RELAXATION      ,  63.91   -20.39                      4.00                              2
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RELAXATICN       ,  63.95   -20.35                      4.00                              3
RELAXATICN       ,  63.98   -20.32                      4.00                              4
RELAXATICN       ,  64.02   -20.28                      4.00                              5
RELAXATICN       ,  64.05   -20.25                      4.00                              6
RELAXATICN       ,  64.09   -20.21                      4.00                              7
RELAXATICN       ,  64.12   -20.18                      4.00                              8
RELAXATICN       ,  64.16   -20.14                      4.00                              9
RELAXATICN       ,  64.19   -20.11                      4.00                             10
RELAXATICN       ,  64.23   -20.07                      4.00                             11
 31.29      3.28 ,  56.14   -20.06   -28.97   -13.11  15C.00   C.24992734E C4   3 12
RELAXATICN       ,  56.25   -19.95                     15.00                             12
RELAXATICN       ,  56.46   -19.73                     15.00                             13
RELAXATICN       ,  56.67   -19.52                     15.00                             14
RELAXATICN       ,  56.89   -19.31                     15.00                             15
RELAXATICN       ,  57.09   -19.10                     15.00                             16
RELAXATICN       ,  57.30   -18.90                     15.00                             17
RELAXATICN       ,  57.50   -18.69                     15.00                             18
RELAXATICN       ,  57.70   -18.49                     15.00                             19
RELAXATICN       ,  57.89   -18.30                     15.00                             20
RELAXATICN       ,  58.09   -18.10                     15.00                             21
 28.31      3.28 ,  50.08   -18.01   -26.92    -5.00  44C.00   0.302295C7E C4   4 22
RELAXATICN       ,  50.44   -17.65                     44.00                             22
RELAXATICN       ,  51.15   -16.94                     44.00                             23
RELAXATICN       ,  51.84   -16.25                     44.00                             24
RELAXATICN       ,  52.50   -15.58                     44.00                             25
RELAXATICN       ,  53.15   -14.94                     44.00                             26
RELAXATICN       ,  53.77   -14.32                     44.00                             27
RELAXATICN       ,  54.37   -13.72                     44.00                             28
RELAXATICN       ,  54.95   -13.14                     44.00                             29
RELAXATICN       ,  55.51   -12.58                     44.00                             30
RELAXATICN       ,  56.06   -12.03                     44.00                             31
 25.33      3.28 ,  48.22   -11.76   -20.68     0.0   ******   0.37305303E C4   5 32
RELAXATICN       ,  49.05   -10.93                    136.00                             32
RELAXATICN       ,  50.65    -9.33                    136.00                             33
RELAXATICN       ,  52.12    -7.86                    136.00                             34
RELAXATICN       ,  53.47    -6.51                    136.00                             35
RELAXATICN       ,  54.71    -5.27                    136.00                             36
RELAXATICN       ,  55.85    -4.13                    136.00                             37
RELAXATICN       ,  56.90    -3.08                    136.00                             38
RELAXATICN       ,  57.87    -2.11                    136.00                             39
RELAXATICN       ,  58.76    -1.22                    136.00                             40
RELAXATICN       ,  59.57    -0.41                    136.00                             41
 22.35      3.28 ,  51.86    -0.02    -8.93     0.0   ******   0.47195547E C4   6 42
RELAXATICN       ,  52.37     C.50                    25C.00                             42
RELAXATICN       ,  53.34     1.46                    25C.00                             43
RELAXATICN       ,  54.20     2.32                    25C.00                             44
RELAXATICN       ,  54.95     3.08                    25C.00                             45
RELAXATICN       ,  55.62     3.75                    25C.0C                             46
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RELAXATION     ,  56.22    4.34                    250.00                                 47
RELAXATION     ,  56.74    4.87                    250.00                                 48
RELAXATION     ,  57.21    5.33                    250.00                                 49
RELAXATION     ,  57.62    5.74                    250.00                                 50
RELAXATION     ,  57.98    6.11                    250.00                                 51
 19.37    3.28    50.05    6.28    -2.64     0.0   ******   0.61621797E 04   7 52
 16.39    3.28    44.09    8.43    -0.49     0.0   ******   0.83860000E 04   8 53
 13.41    3.28    36.39    8.83    -0.08     0.0   ******   0.12079809E 05   9 54
 10.43    3.28    28.36    8.90    -0.01     0.0   ******   0.18907535E 05  10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

        STEP          PLASTIC STRAIN          MAX CR MIN                DAMAGE
           1              0.00706               MAX               0.603239E-03
                                   DAMAGE FROM PLASTIC STRAINS= 0.60323928E-03

       SIGMAX   SIGMIN          RNCYC          CYCLES             ENN/CYC
        72.00   -20.40            16.      0.99999805E 04   0.16000031E-02
        63.91   -20.39             4.      0.10991109E 05   0.36393036E-03
        63.95   -20.35             4.      0.10971137E 05   0.36459300E-03
        63.98   -20.32             4.      0.10951203E 05   0.36525656E-03
        64.02   -20.28             4.      0.10938156E 05   0.36569219E-03
        64.05   -20.25             4.      0.10931410E 05   0.36591780E-03
        64.09   -20.21             4.      0.10919895E 05   0.36630384E-03
        64.12   -20.18             4.      0.10897375E 05   0.36706077E-03
        64.16   -20.14             4.      0.10886496E 05   0.36742748E-03
        64.19   -20.11             4.      0.10866238E 05   0.36811247E-03
        64.23   -20.07             4.      0.10866332E 05   0.36810944E-03
        56.25   -19.95            15.      0.20582109E 05   0.72878809E-03
        56.46   -19.73            15.      0.20355750E 05   0.73689246E-03
        56.67   -19.52            15.      0.20136930E 05   0.74489997E-03
        56.89   -19.31            15.      0.19923332E 05   0.75288606E-03
        57.09   -19.10            15.      0.19717301E 05   0.76075317E-03
        57.30   -18.90            15.      0.19512488E 05   0.76873833E-03
        57.50   -18.69            15.      0.19313871E 05   0.77664386E-03
        57.70   -18.49            15.      0.19118684E 05   0.78457268E-03
        57.89   -18.30            15.      0.18930270E 05   0.79238159E-03
        58.09   -18.10            15.      0.18745156E 05   0.80020656E-03
        50.44   -17.65            44.      0.48274484E 05   0.91145444E-03
        51.15   -16.94            44.      0.46130172E 05   0.95382240E-03
        51.84   -16.25            44.      0.44135836E 05   0.99692214E-03
        52.50   -15.58            44.      0.42277648E 05   0.10407390E-02
        53.15   -14.94            44.      0.40551523E 05   0.10850392E-02
        53.77   -14.32            44.      0.38937594E 05   0.11300133E-02
        54.37   -13.72            44.      0.37430422E 05   0.11755142E-02
        54.95   -13.14            44.      0.36023273E 05   0.12214326E-02
        55.51   -12.58            44.      0.34707199E 05   0.12677484E-02
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56.06  -12.03         44.          0.33473281E 05  0.13144810E-02
49.05  -10.93        136.          0.11033494E 06  0.12326103E-02
50.65   -9.33        136.          0.97210188E 05  0.13990302E-02
52.12   -7.86        136.          0.86354438E 05  0.15749044E-02
53.47   -6.51        136.          0.77311188E 05  0.17591242E-02
54.71   -5.27        136.          0.69733688E 05  0.19502768E-02
55.85   -4.13        136.          0.63343938E 05  0.21470089E-02
56.90   -3.08        136.          0.57930816E 05  0.23476277E-02
57.87   -2.11        136.          0.53320855E 05  0.25505966E-02
58.76   -1.22        136.          0.49367605E 05  0.27548429E-02
59.57   -0.41        136.          0.45970492E 05  0.29584193E-02
52.37    0.50        250.          0.20244175E 06  0.12349230E-02
53.34    1.46        250.          0.18366988E 06  0.13611377E-02
54.20    2.32        250.          0.16833456E 06  0.14851375E-02
54.95    3.08        250.          0.15569025E 06  0.16057524E-02
55.62    3.75        250.          0.14520594E 06  0.17216925E-02
56.22    4.34        250.          0.13643463E 06  0.18323793E-02
56.74    4.87        250.          0.12905781E 06  0.19371163E-02
57.21    5.33        250.          0.12282413E 06  0.20354306E-02
57.62    5.74        250.          0.11752700E 06  0.21271706E-02
57.98    6.11        250.          0.11300669E 06  0.22122583E-02
50.05    6.28       4500.          0.81512081E 06  0.55206530E-02
44.09    8.43       6500.          0.77923370E 07  0.83415280E-03
36.39    8.83       9500.          0.20005853E 09  0.47486101E-04
28.36    8.90      17000.          0.47726305E 10  0.35619769E-05

                         DAMAGE PER THIS SET= 0.69242597E-01

                          TOTAL ENN/CYC =, 0.13848418E 00
```

```
INPUT OF BLOCK LOADS


   1  2  2
A7 CRITICAL POINT #1 FROM U166808
7075-T6 AL               72.            C.4         -1.836  10000.
          -.0020         .2801          71.7MIL-HDBK-5A  4 7075
          -.0022         .5154          56.3MIL-HDBK-5A  5 7075
          -.0014         .6141          44.6MIL-HDBK-5A  6 7075
          -.0013         .6838          38.1MIL-HDBK-5A  7 7075
       10000000.           1.             1.
            2.72
       2      10      10
            29.8
   1   1              .11           1.25            16.
   2   2              .11           1.15            40.
   3   3              .11           1.05           150.
   4   4              .11            .95           440.
   5   5              .11            .85          1360.
   6   6              .11            .75          2500.
   7   7              .11            .65          4500.
   8   8              .11            .55          6500.
   9   9              .11            .45          9500.
  10  10              .11            .35         17000.
   1  10   9   8   7   6   5   4   3   2   1
   2   1   2   3   4   5   6   7   8   9  10
```

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OUTPLT CF BLOCK LOADS, IPRINT = 2



   1 CATA CECKS ARE TO BE PROCESSED.
NO CCLNTING METHCDS USED
SEQUENCE ACCOUNTABLE FATIGUE EVALUATICN
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SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U166808
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --           72.00000

LCF STRAIN INTERCEPT =            0.40000

INVERSE OF COFFIN-MANSON SLOPE            -1.83600

ELASTIC MODULUS =       10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE               A(I)                B(I)                C(I)
   10** 4           -0.00200            0.28010            71.70000
   10** 5           -0.00220            0.51540            56.29999
   10** 6           -0.00140            0.61410            44.59999
   10** 7           -0.00130            0.68380            38.09999

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  MIL-HDBK-5A

RESIDUAL STRESS RELAXATION FUNCTION

    ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = 0.10000000E 08 ,   E1 =     1.000 AND  E2 =     1.000


       2 TIMES THROUGH BLOCK OF        10 LOADS

     LOAD LIMIT =          29.79999


STEP  TYPE            STMIN               STMAX               ENN
   1     1          0.11000             1.25000            16.00000
   2     2          0.11000             1.15000            40.00000
   3     3          0.11000             1.05000           150.00000
   4     4          0.11000             0.95000           440.00000
   5     5          0.11000             0.85000          1360.00000
   6     6          0.11000             0.75000          2500.00000
   7     7          0.11000             0.65000          4500.00000
   8     8          0.11000             0.55000          6500.00000
   9     9          0.11000             0.45000          9500.00000
  10    10          0.11000             0.35000         17000.00000


BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE      TYPE
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1	10	9	8	7	6	5	4	3	2	1
2	1	2	3	4	5	6	7	8	9	10

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SPECTRUM FRCM  A7 CRITICAL POINT #1 FRCM U166808

AKT =   2.72

RELAXATICN CONSTANT C1=     10000000.00
FLIGHT CR BLOCK NO.     1
 STMAX     STMIN     SIGMAX    SIGMIN     RES      EQRES     ENN            NEP
 37.25      3.28     72.00    -20.40      0.0     -29.32    16.00   0.17906543E 04   1  1
 34.27      3.28     63.89    -20.40   -29.32     -21.21    40.00   0.21008384E 04   2  2
RELAXATICN       ,   63.91    -20.39                         4.00                            2
RELAXATICN       ,   63.95    -20.35                         4.00                            3
RELAXATICN       ,   63.98    -20.32                         4.00                            4
RELAXATICN       ,   64.02    -20.28                         4.00                            5
RELAXATICN       ,   64.05    -20.25                         4.00                            6
RELAXATICN       ,   64.09    -20.21                         4.00                            7
RELAXATICN       ,   64.12    -20.18                         4.00                            8
RELAXATICN       ,   64.16    -20.14                         4.00                            9
RELAXATICN       ,   64.19    -20.11                         4.00                           10
RELAXATICN       ,   64.23    -20.07                         4.00                           11
 31.29      3.28     56.14    -20.06   -28.97     -13.11   150.00   0.24992734E 04   3 12
RELAXATICN       ,   56.25    -19.95                        15.00                           12
RELAXATICN       ,   56.46    -19.73                        15.00                           13
RELAXATICN       ,   56.67    -19.52                        15.00                           14
RELAXATICN       ,   56.89    -19.31                        15.00                           15
RELAXATICN       ,   57.09    -19.10                        15.00                           16
RELAXATICN       ,   57.30    -18.90                        15.00                           17
RELAXATICN       ,   57.50    -18.69                        15.00                           18
RELAXATICN       ,   57.70    -18.49                        15.00                           19
RELAXATICN       ,   57.89    -18.30                        15.00                           20
RELAXATICN       ,   58.09    -18.10                        15.00                           21
 28.31      3.28     50.08    -18.01   -26.92      -5.00   440.00   0.30229507E 04   4 22
RELAXATICN       ,   50.44    -17.65                        44.00                           22
RELAXATICN       ,   51.15    -16.94                        44.00                           23
RELAXATICN       ,   51.84    -16.25                        44.00                           24
RELAXATICN       ,   52.50    -15.58                        44.00                           25
RELAXATICN       ,   53.15    -14.94                        44.00                           26
RELAXATICN       ,   53.77    -14.32                        44.00                           27
RELAXATICN       ,   54.37    -13.72                        44.00                           28
RELAXATICN       ,   54.95    -13.14                        44.00                           29
RELAXATICN       ,   55.51    -12.58                        44.00                           30
RELAXATICN       ,   56.06    -12.03                        44.00                           31
 25.33      3.28     48.22    -11.76   -20.68       0.0     *****   0.37305303E 04   5 32
RELAXATICN       ,   49.05    -10.93                       136.00                           32
RELAXATICN       ,   50.65     -9.33                       136.00                           33
RELAXATICN       ,   52.12     -7.86                       136.00                           34
RELAXATICN       ,   53.47     -6.51                       136.00                           35
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RELAXATION    ,   54.71    -5.27                        136.00                             36
RELAXATION    ,   55.85    -4.13                        136.00                             37
RELAXATION    ,   56.90    -3.08                        136.00                             38
RELAXATION    ,   57.87    -2.11                        136.00                             39
RELAXATION    ,   58.76    -1.22                        136.00                             40
RELAXATION    ,   59.57    -0.41                        136.00                             41
 22.35      3.28  51.86    -0.02    -8.93      0.0     ******  0.47195547E 04   6 42
RELAXATION    ,   52.37     0.50                        250.00                             42
RELAXATION    ,   53.34     1.46                        250.00                             43
RELAXATION    ,   54.20     2.32                        250.00                             44
RELAXATION    ,   54.95     3.08                        250.00                             45
RELAXATION    ,   55.62     3.75                        250.00                             46
RELAXATION    ,   56.22     4.34                        250.00                             47
RELAXATION    ,   56.74     4.87                        250.00                             48
RELAXATION    ,   57.21     5.33                        250.00                             49
RELAXATION    ,   57.62     5.74                        250.00                             50
RELAXATION    ,   57.98     6.11                        250.00                             51
 19.37      3.28  50.05     6.28    -2.64      0.0     ******  0.61621797E 04   7 52
 16.39      3.28  44.09     8.43    -0.49      0.0     ******  0.83860000E 04   8 53
 13.41      3.28  36.39     8.83    -0.08      0.0     ******  0.12079809E 05   9 54
 10.43      3.28  28.36     8.90    -0.01      0.0     ******  0.18907535E 05  10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

       STEP           PLASTIC STRAIN          MAX OR MIN               DAMAGE
         1               0.00706                 MAX              0.603661E-03
                                  DAMAGE FROM PLASTIC STRAINS= 0.60366094E-03

      SIGMAX   SIGMIN            RNCYC        CYCLES              ENN/CYC
       72.00   -20.40             16.         0.99999805E 04   0.16000031E-02
       63.91   -20.39              4.         0.10991109E 05   0.36393036E-03
       63.95   -20.35              4.         0.10971137E 05   0.36459300E-03
       63.98   -20.32              4.         0.10951203E 05   0.36525656E-03
       64.02   -20.28              4.         0.10938156E 05   0.36569219E-03
       64.05   -20.25              4.         0.10931410E 05   0.36591780E-03
       64.09   -20.21              4.         0.10919895E 05   0.36630384E-03
       64.12   -20.18              4.         0.10897375E 05   0.36706077E-03
       64.16   -20.14              4.         0.10886496E 05   0.36742748E-03
       64.19   -20.11              4.         0.10866238E 05   0.36811247E-03
       64.23   -20.07              4.         0.10866332E 05   0.36810944E-03
       56.25   -19.95             15.         0.20582109E 05   0.72878809E-03
       56.46   -19.73             15.         0.20355750E 05   0.73689246E-03
       56.67   -19.52             15.         0.20136930E 05   0.74489997E-03
       56.89   -19.31             15.         0.19923332E 05   0.75288606E-03
       57.09   -19.10             15.         0.19717301E 05   0.76075317E-03
       57.30   -18.90             15.         0.19512488E 05   0.76873833E-03
       57.50   -18.69             15.         0.19313871E 05   0.77664386E-03
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          57.70  -18.49          15.         0.19118684E 05  0.78457268E-03
          57.89  -18.30          15.         0.18930270E 05  0.79238159E-03
          58.09  -18.10          15.         0.18745156E 05  0.80020656E-03
          50.44  -17.65          44.         0.48274484E 05  0.91145444E-03
          51.15  -16.94          44.         0.46130172E 05  0.95382240E-03
          51.84  -16.25          44.         0.44135836E 05  0.99692214E-03
          52.50  -15.58          44.         0.42277648E 05  0.10407390E-02
          53.15  -14.94          44.         0.40551523E 05  0.10850392E-02
          53.77  -14.32          44.         0.38937594E 05  0.11300133E-02
          54.37  -13.72          44.         0.37430422E 05  0.11755142E-02
          54.95  -13.14          44.         0.36023273E 05  0.12214326E-02
          55.51  -12.58          44.         0.34707199E 05  0.12677484E-02
          56.06  -12.03          44.         0.33473281E 05  0.13144810E-02
          49.05  -10.93         136.         0.11033494E 06  0.12326103E-02
          50.65   -9.33         136.         0.97210188E 05  0.13990302E-02
          52.12   -7.86         136.         0.86354438E 05  0.15749044E-02
          53.47   -6.51         136.         0.77311188E 05  0.17591242E-02
          54.71   -5.27         136.         0.69733688E 05  0.19502768E-02
          55.85   -4.13         136.         0.63343938E 05  0.21470089E-02
          56.90   -3.08         136.         0.57930816E 05  0.23476277E-02
          57.87   -2.11         136.         0.53320855E 05  0.25505966E-02
          58.76   -1.22         136.         0.49367605E 05  0.27548429E-02
          59.57   -0.41         136.         0.45970492E 05  0.29584193E-02
          52.37    0.50         250.         0.20244175E 06  0.12349230E-02
          53.34    1.46         250.         0.18366988E 06  0.13611377E-02
          54.20    2.32         250.         0.16833456E 06  0.14851375E-02
          54.95    3.08         250.         0.15569025E 06  0.16057524E-02
          55.62    3.75         250.         0.14520594E 06  0.17216925E-02
          56.22    4.34         250.         0.13643463E 06  0.18323793E-02
          56.74    4.87         250.         0.12905781E 06  0.19371163E-02
          57.21    5.33         250.         0.12282413E 06  0.20354306E-02
          57.62    5.74         250.         0.11752700E 06  0.21271706E-02
          57.98    6.11         250.         0.11300669E 06  0.22122583E-02
          50.05    6.28        4500.         0.81512081E 06  0.55206530E-02
          44.09    8.43        6500.         0.77923370E 07  0.83415280E-03
          36.39    8.83        9500.         0.20005853E 09  0.47486101E-04
          28.36    8.90       17000.         0.47726305E 10  0.35619769E-05

                                   DAMAGE PER THIS SET= 0.69243014E-01

                                    TOTAL ENN/CYC =, 0.69243014E-01
FLIGHT CR BLOCK NO.     2
 STMAX    STMIN    SIGMAX    SIGMIN    RES     EQRES    ENN            NEP
 37.25     3.28    72.00   -20.40    -0.01   -29.32   16.00   0.17906543E 04   1   1
 34.27     3.28    63.89   -20.40   -29.32   -21.21   40.00   0.21008384E 04   2   2
RELAXATICN      ,  63.91   -20.39                      4.00                                2
RELAXATICN      ,  63.95   -20.35                      4.00                                3
RELAXATICN      ,  63.98   -20.32                      4.00                                4
```

```
RELAXATICN     ,  64.02  -20.28                          4.00                            5
RELAXATICN     ,  64.05  -20.25                          4.00                            6
RELAXATICN     ,  64.09  -20.21                          4.00                            7
RELAXATICN     ,  64.12  -20.18                          4.00                            8
RELAXATICN     ,  64.16  -20.14                          4.00                            9
RELAXATICN     ,  64.19  -20.11                          4.00                           10
RELAXATICN     ,  64.23  -20.07                          4.00                           11
 31.29    3.28 ,  56.14  -20.06  -28.97  -13.11  150.00  0.24992734E 04  3 12
RELAXATICN     ,  56.25  -19.95                         15.00                           12
RELAXATICN     ,  56.46  -19.73                         15.00                           13
RELAXATICN     ,  56.67  -19.52                         15.00                           14
RELAXATICN     ,  56.89  -19.31                         15.00                           15
RELAXATICN     ,  57.09  -19.10                         15.00                           16
RELAXATICN     ,  57.30  -18.90                         15.00                           17
RELAXATICN     ,  57.50  -18.69                         15.00                           18
RELAXATICN     ,  57.70  -18.49                         15.00                           19
RELAXATICN     ,  57.89  -18.30                         15.00                           20
RELAXATICN     ,  58.09  -18.10                         15.00                           21
 28.31    3.28 ,  50.08  -18.01  -26.92   -5.00  440.00  0.30229507E 04  4 22
RELAXATICN     ,  50.44  -17.65                         44.00                           22
RELAXATICN     ,  51.15  -16.94                         44.00                           23
RELAXATICN     ,  51.84  -16.25                         44.00                           24
RELAXATICN     ,  52.50  -15.58                         44.00                           25
RELAXATICN     ,  53.15  -14.94                         44.00                           26
RELAXATICN     ,  53.77  -14.32                         44.00                           27
RELAXATICN     ,  54.37  -13.72                         44.00                           28
RELAXATICN     ,  54.95  -13.14                         44.00                           29
RELAXATICN     ,  55.51  -12.58                         44.00                           30
RELAXATICN     ,  56.06  -12.03                         44.00                           31
 25.33    3.28 ,  48.22  -11.76  -20.68    0.0   ******  0.37305303E 04  5 32
RELAXATICN     ,  49.05  -10.93                        136.00                           32
RELAXATICN     ,  50.65   -9.33                        136.00                           33
RELAXATICN     ,  52.12   -7.86                        136.00                           34
RELAXATICN     ,  53.47   -6.51                        136.00                           35
RELAXATICN     ,  54.71   -5.27                        136.00                           36
RELAXATICN     ,  55.85   -4.13                        136.00                           37
RELAXATICN     ,  56.90   -3.08                        136.00                           38
RELAXATICN     ,  57.87   -2.11                        136.00                           39
RELAXATICN     ,  58.76   -1.22                        136.00                           40
RELAXATICN     ,  59.57   -0.41                        136.00                           41
 22.35    3.28 ,  51.86   -0.02   -8.93    0.0   ******  0.47195547E 04  6 42
RELAXATICN     ,  52.37    0.50                        250.00                           42
RELAXATICN     ,  53.34    1.46                        250.00                           43
RELAXATICN     ,  54.20    2.32                        250.00                           44
RELAXATICN     ,  54.95    3.08                        250.00                           45
RELAXATICN     ,  55.62    3.75                        250.00                           46
RELAXATICN     ,  56.22    4.34                        250.00                           47
RELAXATICN     ,  56.74    4.87                        250.00                           48
```

```
RELAXATION     ,  57.21     5.33                         250.00                                   49
RELAXATION     ,  57.62     5.74                         250.00                                   50
RELAXATION     ,  57.98     6.11                         250.00                                   51
 19.37     3.28   50.05     6.28     -2.64      0.0     ******   0.61621797E 04   7 52
 16.39     3.28   44.09     8.43     -0.49      0.0     ******   0.83860000E 04   8 53
 13.41     3.28   36.39     8.83     -0.08      0.0     ******   0.12079809E 05   9 54
 10.43     3.28   28.36     8.90     -0.01      0.0     ******   0.18907535E 05  10 55

LOCAL STRESSES AND PLASTIC STRAINS WITH RESULTING FATIGUE LIFE

        STEP             PLASTIC STRAIN            MAX OR MIN                  DAMAGE
          1                   0.00706                  MAX                0.603239E-03
                                        DAMAGE FROM PLASTIC STRAINS= 0.60323928E-03

         SIGMAX   SIGMIN            RNCYC          CYCLES               ENN/CYC
          72.00   -20.40              16.        0.99999805E 04   0.16000031E-02
          63.91   -20.39               4.        0.10991109E 05   0.36393036E-03
          63.95   -20.35               4.        0.10971137E 05   0.36459300E-03
          63.98   -20.32               4.        0.10951203E 05   0.36525656E-03
          64.02   -20.28               4.        0.10938156E 05   0.36569219E-03
          64.05   -20.25               4.        0.10931410E 05   0.36591780E-03
          64.09   -20.21               4.        0.10919895E 05   0.36630384E-03
          64.12   -20.18               4.        0.10897375E 05   0.36706077E-03
          64.16   -20.14               4.        0.10886496E 05   0.36742748E-03
          64.19   -20.11               4.        0.10866238E 05   0.36811247E-03
          64.23   -20.07               4.        0.10866332E 05   0.36810944E-03
          56.25   -19.95              15.        0.20582109E 05   0.72878809E-03
          56.46   -19.73              15.        0.20355750E 05   0.73689246E-03
          56.67   -19.52              15.        0.20136930E 05   0.74489997E-03
          56.89   -19.31              15.        0.19923332E 05   0.75288606E-03
          57.09   -19.10              15.        0.19717301E 05   0.76075317E-03
          57.30   -18.90              15.        0.19512488E 05   0.76873833E-03
          57.50   -18.69              15.        0.19313871E 05   0.77664386E-03
          57.70   -18.49              15.        0.19118684E 05   0.78457268E-03
          57.89   -18.30              15.        0.18930270E 05   0.79238159E-03
          58.09   -18.10              15.        0.18745156E 05   0.80020656E-03
          50.44   -17.65              44.        0.48274484E 05   0.91145444E-03
          51.15   -16.94              44.        0.46130172E 05   0.95382240E-03
          51.84   -16.25              44.        0.44135836E 05   0.99692214E-03
          52.50   -15.58              44.        0.42277648E 05   0.10407390E-02
          53.15   -14.94              44.        0.40551523E 05   0.10850392E-02
          53.77   -14.32              44.        0.38937594E 05   0.11300133E-02
          54.37   -13.72              44.        0.37430422E 05   0.11755142E-02
          54.95   -13.14              44.        0.36023273E 05   0.12214326E-02
          55.51   -12.58              44.        0.34707199E 05   0.12677484E-02
          56.06   -12.03              44.        0.33473281E 05   0.13144810E-02
          49.05   -10.93             136.        0.11033494E 06   0.12326103E-02
```

```
50.65    -9.33          136.        0.97210188E 05  0.13990302E-02
52.12    -7.86          136.        0.86354438E 05  0.15749044E-02
53.47    -6.51          136.        0.77311188E 05  0.17591242E-02
54.71    -5.27          136.        0.69733688E 05  0.19502768E-02
55.85    -4.13          136.        0.63343938E 05  0.21470089E-02
56.90    -3.08          136.        0.57930816E 05  0.23476277E-02
57.87    -2.11          136.        0.53320855E 05  0.25505966E-02
58.76    -1.22          136.        0.49367605E 05  0.27548429E-02
59.57    -0.41          136.        0.45970492E 05  0.29584193E-02
52.37     0.50          250.        0.20244175E 06  0.12349230E-02
53.34     1.46          250.        0.18366988E 06  0.13611377E-02
54.20     2.32          250.        0.16833456E 06  0.14851375E-02
54.95     3.08          250.        0.15569025E 06  0.16057524E-02
55.62     3.75          250.        0.14520594E 06  0.17216925E-02
56.22     4.34          250.        0.13643463E 06  0.18323793E-02
56.74     4.87          250.        0.12905781E 06  0.19371163E-02
57.21     5.33          250.        0.12282413E 06  0.20354306E-02
57.62     5.74          250.        0.11752700E 06  0.21271706E-02
57.98     6.11          250.        0.11300669E 06  0.22122583E-02
50.05     6.28         4500.        0.81512081E 06  0.55206530E-02
44.09     8.43         6500.        0.77923370E 07  0.83415280E-03
36.39     8.83         9500.        0.20005853E 09  0.47486101E-04
28.36     8.90        17000.        0.47726305E 10  0.35619769E-05

                         DAMAGE PER THIS SET= 0.69242597E-01

                          TOTAL ENN/CYC =, 0.13848418E 00
```

```
INPUT OF RANDU GENERATED LOADS


   1   3   1
A7 CRITICAL POINT #1 FROM U166808
7075-T6 AL                     72.               0.4             -1.836    10000.
            -.0020             .2801              71.7MIL-HDBK-5A      4 7075
            -.0022             .5154              56.3MIL-HDBK-5A      5 7075
            -.0014             .6141              44.6MIL-HDBK-5A      6 7075
            -.0013             .6838              38.1MIL-HDBK-5A      7 7075
         10000000.                1.                1.
              2.72
         1      4201          1
              29.8
   1    1
```

```
OUTPUT OF 4201 RANDU GENERATED LOADS, IPRINT = 3



   1 DATA DECKS ARE TO BE PROCESSED.

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FRCM  A7 CRITICAL PCINT #1 FRCM U166808
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --          72.00000

LCF STRAIN INTERCEPT =             0.40000

INVERSE CF COFFIN-MANSON SLOPE         -1.83600

ELASTIC MCDULUS =        10000.00000

COEFFICIENTS CF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE             A(I)             B(I)             C(I)
   1C** 4          -0.00200          0.28010          71.70000
   1C** 5          -0.00220          0.51540          56.29999
   10** 6          -0.00140          0.61410          44.59999
   1C** 7          -0.00130          0.68380          38.09999

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  MIL-HDBK-5A

RESIDUAL STRESS RELAXATION FUNCTICN

    ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = C.10000000E 08 ,   E1 =      1.000 ANC  E2 =      1.000


      1 TIMES THROUGH BLOCK OF      4201 LOADS

     LCAC LIMIT =          29.79999


STEP  TYPE            STMIN              STMAX             ENN
 201     1            0.0                0.85000           1.00000
 451     1            C.11000            0.45C00           1.000CC
 701     1            C.11000            0.45000           1.00000
 951     1            0.11000            0.75000           1.00000
1201     1            C.11000            0.5500C           1.00000
1451     1            C.11000            0.65C00           1.0000C
1701     1            0.11000            0.35000           1.0000C
1951     1            0.11000            0.45000           1.0000C
2201     1            C.11000            0.35000           1.00000
2451     1            0.11000            0.35000           1.000CC
2701     1            0.11000            0.55000           1.00000
2951     1            0.11000            0.35000           1.00000
3201     1            0.11000            0.35000           1.00000
3451     1            C.11000            0.45000           1.0000C
```

```
3701     1              0.11000          0.35000          1.00000
3951     1              0.11000          0.35000          1.00000
4201     1              0.11000          0.35000          1.00000

BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE     TYPE

   1     1
```

```
SPECTRUM FRCM  A7 CRITICAL PCINT #1 FROM U166808

AKT =   2.72

RELAXATICN CCNSTANT C1=    10000000.00

SPECTRUM SUBJECTED TO THE RANGE-PAIR CCUNTING TECHNIQUE
FLIGHT CR BLOCK NO.    1
                               DAMAGE FROM PLASTIC STRAINS= 0.46892278E-03

                               DAMAGE PER THIS SET= 0.46267733E-C2

                                TCTAL ENN/CYC =, 0.46267733E-02
```

```
INPUT CF RANDL GENERATED LOADS



   1   3   2
A7 CRITICAL PCINT #1 FROM U166808
7075-T6 AL                     72.               C.4              -1.836  10000.
            -.0020             .2801              71.7MIL-HCBK-5A      4 7075
            -.0022             .5154              56.3MIL-HDBK-5A      5 7C75
            -.0014             .6141              44.6MIL-HDBK-5A      6 7C75
            -.0013             .6838              38.1MIL-HCBK-5A      7 7075
         10000000.                1.                1.
              2.72
         1      4201          1
              29.8
   1    1
```

```
OUTPUT OF 4201 RANDU GENERATED LOADS, IPRINT = 3



   1 DATA DECKS ARE TO BE PROCESSED.
NO COUNTING METHODS USED
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FRCM  A7 CRITICAL POINT #1 FRCM U166808
MATERIAL TYPE -- 7075-T6 AL

TENSILE YIELD STRESS (KSI) --            72.00000

LCF STRAIN INTERCEPT =               0.40000

INVERSE OF COFFIN-MANSON SLOPE             -1.8360C

ELASTIC MODULUS =        10000.00000

COEFFICIENTS CF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
    SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE              A(I)                B(I)                C(I)
   10** 4            -0.00200            0.28010            71.70C00
   1C** 5            -0.00220            0.51540            56.29999
   10** 6            -0.00140            0.61410            44.59999
   10** 7            -0.00130            0.68380            38.09999

UNNCTCHEC COUPON S-N DATA DERIVED FROM
INFORMATICN SUPPLIED FRCM  MIL-HDBK-5A

RESICUAL STRESS RELAXATION FUNCTICN

    ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 = 0.10000000E 08 ,   E1 =     1.000 ANC  E2 =     1.000


        1 TIMES THROUGH BLOCK OF       4201 LOACS

     LCAC LIMIT =           29.79999


STEP  TYPE             STMIN               STMAX               ENN
 201     1             0.0                 0.85000            1.00000
 451     1             0.11000             0.45000            1.0000C
 701     1             0.11000             0.45000            1.0000C
 951     1             0.11000             0.75000            1.00000
1201     1             0.11000             0.5500C            1.00000
1451     1             0.11000             0.65000            1.0000C
1701     1             0.11000             0.35000            1.00000
1951     1             0.11000             0.45000            1.00000
2201     1             0.11000             0.35000            1.0C000
2451     1             0.11000             0.35000            1.0000C
2701     1             0.11000             0.55000            1.00000
2951     1             0.11000             0.35000            1.00000
3201     1             C.11000             0.35000            1.00000
3451     1             0.11000             0.45000            1.C000C
```

```
3701     1               0.11000             0.35000             1.00000
3951     1               0.11000             0.35000             1.00000
4201     1               C.11000             0.35000             1.00000

BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE      TYFE

   1    1
```

```
SPECTRUM FROM  A7 CRITICAL POINT #1 FROM U166808

AKT =    2.72

RELAXATION CONSTANT C1=    10000000.00
FLIGHT OR BLOCK NO.     1
                                        DAMAGE FROM PLASTIC STRAINS= 0.46892278E-03
                                        DAMAGE PER THIS SET= 0.47398917E-02
                                         TOTAL ENN/CYC =, 0.47398917E-02
```

COMPUTER PROGRAM

```
C
C     **************************************************
C
C
C                       MODULE I
C                  INPUT ROUTINE FOR THE
C          SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS
C
C     **************************************************
C
C
C     INPUT
C
C
C     DATA CARD 1.     NDECK = THE NUMBER OF DATA DECKS TO
C                             BE RUN SEQUENTIALLY
C                      IPRINT= THE VALUE CONTROLLING THE
C                             WRITE STATEMENTS
C                             1. PERMITS MAXIMUM PRINTOUT
C                             2. SUPPRESSES RANGE-PAIR
C                                PRINTING
C                             3. MAXIMUM SUPPRESSION OF
C                                PRINTOUT
C                      IRPCM = THE VALUE CONTROLLING THE
C                             ENTRY INTO THE RANGE-PAIR
C                             COUNTING SUBROUTINE
C                             1. ENTER RANGE-PAIR COUNTING
C                                SUBROUTINE
C                             2. SKIP RANGE-PAIR COUNTING
C                                SUBROUTINE
C                      FORMAT  3I4
C
C     EACH DATA DECK CONTAINS THE FOLLOWING CARDS -
C
C     CARD 1.          TEST IDENTIFYING INFORMATION
C                      FORMAT 16A4
C
C     CARD 2.          TM =    MATERIAL TYPE
C                      TYS =   TENSILE YIELD STRESS (KSI)
C                      EPSD =  LCF STRAIN INTERCEPT
C                      COFMAN =INVERSE OF COFFIN-MANSON
C                             SLOPE
C                      ELMOD = MODULUS OF ELASTICITY (KSI)
C                      FORMAT 4A4,3F18.5,F10.2
C
C     CARDS 3,...,6.   A(N)  N=4,7  (A,B,C ARE COEFFICIENTS
C                                   OF SECOND ORDER LEAST
C                      B(N)         SQUARE FIT OF S-N DATA,
C                                   FOR CURVE OF 10**N
C                      C(N)         CYCLES.)
C                                   (STMAX = A(N)*STMIN**2
C                                     + B(N)*STMIN + C(N))
C                      TITLE1       (TITLE1,TITLE2,TITLE3,
C                      TITLE2       TITLE4 IDENTIFIES THE
C                      TITLE3       SOURCE OF THE
C                      TITLE4       S-N DATA)
C                      N            (PUNCHED IN COLUMN 72.
C                                   FOR INFO.)
C                      MATERIAL TYPE (COLUMNS 73.-80. FOR
C                                    INFO ONLY.)
C                      FORMAT 3F18.5,4A4
C
C     CARD 7.          C1     (CONSTANTS TO BE USED IN
C                             CALCULATION OF EQUILIBRIUM
C                      E1     PERIOD, ENEP.)
C                             (ENEP=C1/(KTSMAX**E1*KTSMEAN
C                      E2     **E2))
C                      FORMAT   3F18.5
```

```
C
C     CARD 8.          AKT =   STRESS CONCENTRATION FACTOR
C                              USED THE FIRST TIME THROUGH
C                              THE PROGRAM
C                      FORMAT   F18.5
C
C     CARD 9.          NBLOCK = NUMBER OF BLOCKS (NO. OF
C                                TIMES TO REPEAT LIST OF
C                                LOADS)
C                      NLEVEL = NUMBER OF LOADS
C                      NTYPE =  NUMBER OF TYPES OF LOADS
C                      FORMAT  3I10
C
C     CARD 10.         TLL = LIMIT LOAD (KSI)
C                      FORMAT  F18.5
C
C     CARDS 11,...,    NLEVEL + 10.
C                      K          THE KTH STEP (K=1,NLEVEL)
C                      ITYPE(K) = IDENTIFYING TYPE OF
C                                 THE KTH LOAD
C                      STMIN(K) = THE KTH MINIMUM (DECIMAL
C                                 FRACTION OF TLL)
C                      STMAX(K) = THE KTH MAXIMUM (DECIMAL
C                                 FRACTION OF TLL)
C                      ENN(K)   = NUMBER OF CYCLES AT THE
C                                 KTH LOAD
C                      FORMAT  2(I4,2X),3(F18.5,1X)
C
C     CARDS NLEVEL + 11,...,NLEVEL + 10 + NBLOCK.
C                      JJ      THE JJTH BLOCK (JJ=1,NBLOCK)
C                      NN(JJ,1) = TYPE OF LOAD INCLUDED IN
C                                 JJTH BLOCK
C                      NN(JJ,2) = (THERE WILL BE ONE NN
C                                 VALUE ON THE CARD FOR
C                      NN(JJ, ) = EACH DIFFERENT TYPE OF
C                                 LOAD INCLUDED IN THE JJTH
C                                 BLOCK)
C                      FORMAT  9I5
C
C
C
C
```

```
      COMMON/MSAL/RNCYC( 4205),KPMAX,IPRINT
      DIMENSION RTMIN(4205),RTMAX(4205),ITYPE(4205),RNN(4205
     1)
      COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSD,COFMAN,
     1RES( 4205),AKT,SUMENN,SUMNC,C1,E2,E1
      COMMON/MCOR2/STMIN( 4205),STMAX( 4205),ENN( 4205),
     1C(10),R(10),NN(20,10),A(10),B(10)
      DIMENSION HOLD(101)
C
C
C     INSERT RANDU PACKET HERE - REMOVE ISKIP=0 CARD
      ISKIP=0
      READ(5,4) NDECK,IPRINT,IRPCM
4     FORMAT(3I4)
      WRITE(6,3) NDECK
3     FORMAT(1H1,I4,32H DATA DECKS ARE TO BE PROCESSED.)
      IF (IRPCM.GE.2) GO TO 6
      WRITE(6,11)
      GO TO 13
6     WRITE(6,7)
7     FORMAT(25H NO COUNTING METHODS USED)
13    CONTINUE
      DO 595 LMN = 1,NDECK
      WRITE(6,5)
5     FORMAT(40H SEQUENCE ACCOUNTABLE FATIGUE EVALUATION)
      READ(5,9)T1,T2,T3,T4,T5,T6,T7,T8,T9,T10,T11,T12,T13,T1
     14,T15,T16
9     FORMAT(16A4)
      WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8,T9,T10,T11,T12,T13,T
     114,T15,T16
8     FORMAT(16H1SPECTRUM FROM  ,16A4)
C
C
C               INPUT OF DATA PECULIAR TO A MATERIAL
C
C
      READ(5,10)TM1,TM2,TM3,TM4,TYS,EPSD,COFMAN,ELMOD
10    FORMAT(4A4,3F18.5,F10.2)
      WRITE(6,12)TM1,TM2,TM3,TM4,TYS,EPSD,COFMAN,ELMOD
12    FORMAT(18H MATERIAL TYPE -- ,4A4,//16H TENSILE YIELD S
     114HTRESS (KSI) --,F18.5,
     1       //23H LCF STRAIN INTERCEPT =,F18.5,//
     131H INVERSE OF COFFIN-MANSON SLOPE,F18.5,//
     118H ELASTIC MODULUS =,F18.5)
      READ(5,14)(A(N),B(N),C(N),TITLE1,TITLE2,TITLE3,TITLE4,
     1N=4,7)
14    FORMAT(3F18.5,4A4)
      WRITE(6,16)
16    FORMAT(44H0COEFFICIENTS OF SECOND ORDER LEAST SQUARE F
     114HIT OF S-N DATA)
      WRITE(6,18)
18    FORMAT(43H      SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I))
      WRITE(6,20)
20    FORMAT(5X,5H LIFE,10X,5H A(I),14X,5H B(I),14X,5H C(I))
      WRITE(6,22)(N,A(N),B(N),C(N),N=4,7)
22    FORMAT(8H    10**,I2,3F18.5)
      WRITE(6,56)TITLE1,TITLE2,TITLE3,TITLE4
56    FORMAT(39H0UNNOTCHED COUPON S-N DATA DERIVED FROM/
     128H INFORMATION SUPPLIED FROM  ,4A4)
      READ(5,14) C1,E1,E2
      WRITE(6,24)
24    FORMAT(36H0RESIDUAL STRESS RELAXATION FUNCTION)
      WRITE(6,26)
26    FORMAT(/41H     ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)/)
      WRITE(6,28) C1,E1,E2
28    FORMAT(13H+WHERE   C1 =,E15.8,9H ,   E1 =,F10.3,
     110H AND  E2 =,F10.3)
C
C
```

```
C
C                 INPUT  OF DATA PECULIAR TO A SEQUENCE
C
C
      READ(5,65)AKT
65    FORMAT(F18.5)
      READ(5,32) NBLOCK,JLEVEL,NTYPE
32    FORMAT(3I10)
      WRITE(6,34) NBLOCK,JLEVEL
34    FORMAT(//I10,23H TIMES THROUGH BLOCK OF,I10,6H LOADS)
      READ(5,35) TLL
35    FORMAT(F18.5)
      WRITE(6,33) TLL
33    FORMAT(/ 5X,13H LOAD LIMIT =,F18.5)
      IF(ISKIP.EQ.100) GO TO 37
      READ(5,88)(IDUMMY   ,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),
     1K=1,JLEVEL)
88    FORMAT(I4,2X,I4,2X,F18.5,1X,F18.5,1X,F18.5,1X)
37    WRITE(6,38)
38    FORMAT(//11H STEP  TYPE,10X,6H STMIN,14X,6H STMAX,15X,
     14H ENN)
      IF(ISKIP.EQ.100) GO TO 89
      WRITE(6,36)(K,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=1,
     1JLEVEL)
      GO TO 91
89    WRITE(6,36)(K,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=201,
     1JLEVEL,250)
91    WRITE(6,39)
36    FORMAT(1X,I4,2X,I4,2X,F18.5,1X,F18.5,1X,F18.5)
39    FORMAT(//47H BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE
     15H TYPE/)
      DO 42 JJ=1,NBLOCK
      READ(5,40) IDUMMY     ,(NN(JJ,KK),KK=1,NTYPE)
      WRITE(6,40)     JJ     ,(NN(JJ,KK),KK=1,NTYPE )
40    FORMAT(13I5)
42    CONTINUE
      SUMENN=0.0
      SUMNC=0.0
      RES(1)=0.0
      WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8,T9,T10,T11,T12,T13,T
     114,T15,T16
      WRITE(6,51)  (AKT)
51    FORMAT(//7H AKT = ,(F6.2))
      WRITE(6,55)C1
55    FORMAT(//24H RELAXATION CONSTANT C1=,F15.2)
      IF (IRPCM.GE.2) GO TO 59
      WRITE(6,11)
11    FORMAT(38H0SPECTRUM SUBJECTED TO THE RANGE-PAIR
     118HCOUNTING TECHNIQUE)
59    CONTINUE
      DO 1002 KFL=1,NBLOCK
      JJJ=1
      DO 60 J=1,JLEVEL
      DO 70 KK=1,NTYPE
      IF (NN(KFL,KK).EQ.0) GO TO 60
      IF (ITYPE(J).EQ.NN(KFL,KK)) GO TO 150
70    CONTINUE
150   STMIN(JJJ)=RTMIN(J)*TLL
      STMAX(JJJ)=RTMAX(J)*TLL
      ENN(JJJ)=RNN(J)
      JJJ=JJJ+1
60    CONTINUE
      NLEVEL=JJJ-1
      CALL CORE(KFL)
      IPRINT=2
1002  CONTINUE
597   CONTINUE
595   CONTINUE
596   CONTINUE
580   STOP
      END
C
```

```
      SUBROUTINE CORE(KFL)
C     ***************************************************
C
C                    CORE PROGRAM OF
C        THE SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS
C
C
C                       MODULE II
C
C            LOCAL STRESS AND STRAIN DETERMINATION
C
C     ***************************************************
C
      COMMON/MDEC1/SIGMAX( 4205),SIGMIN( 4205)
      COMMON/MSAL/RNCYC( 4205),KPMAX,IPRINT
      DIMENSION PLSTRA( 4205),EN( 4205),EX( 4205)
      COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSC,COFMAN,
     1RES( 4205),AKT,SUMENN,SUMNC,C1,E2,E1
      COMMON/MCOR2/STMIN( 4205),STMAX( 4205),ENN( 4205),
     1C(10),R(10),NN(20,10),A(10),B(10)
      JJ=KFL
      IF (JJ.GT.3) IPRINT=3
      IRAIN=1
      WRITE(6,54) JJ
54    FORMAT(20H FLIGHT OR BLOCK NO.,I5)
      IF (IPRINT.GE.3) GO TO 61
      WRITE(6,62)
62    FORMAT(1X,6H STMAX,3X,5HSTMIN,3X,6HSIGMAX,3X,6HSIGMIN,
     13X,3HRES,3X,5HEQRES,3X,3HENN,11X,3HNEP)
61    CONTINUE
C
C
148   DO 570 J=1,NLEVEL
149   I=J+1
      PLSTRA(J)=0.0
C
C
C     DETERMINE SEQUENCE ACCOUNTABLE RESIDUAL STRESS AND
C
C         CORRESPONDING PLASTIC STRAIN
C
150   ASMAX=AKT*STMAX(J)
      ASMIN=AKT*STMIN(J)
      ASMEAN=(ASMAX+ASMIN)/2.
      JA=0
170   IF (RES(I-1)+ASMIN+TYS) 190,190,200
190   JA=1
      AAA=RES(I-1)+ASMIN
      PLSTRA(J) = -1.*(AAA/ELMOD)*(1.+AAA/TYS)
200   JB=0
202   IF (RES(I-1)+ASMAX-TYS) 220,210,210
210   JB=-1
      AAA=ASMAX
      BBB=TYS-RES(I-1)
      IF (BBB.GE.TYS) GO TO 214
212   BBB=0.0
214   PLSTRA(J) = AAA*AAA/(ELMOD*TYS)-BBB*BBB/(ELMOD*TYS)
220   IF (JA+JB) 230,250,240
230   RES(I)=TYS-ASMAX
      GO TO 290
240   RES(I)=-TYS-ASMIN
      GO TO 290
250   IF(JA) 260,260,270
260   RES(I)=RES(I-1)
      GO TO 290
270   RES(I)=-ASMEAN
290   SIGMAX(IRAIN)=RES(I)+ASMAX
      SIGMIN(IRAIN)=RES(I)+ASMIN
      RNCYC(IRAIN)=ENN(J)
```

```
      IF (ASMAX.LE.TYS) GO TO 410
400   EQRES=-ASMAX+TYS
      GO TO 440
410   IF (ASMIN.GE.-TYS) GO TO 430
420   EQRES=-ASMIN-TYS
      GO TO 440
430   EQRES=0.0
440   DIF=RES(I)-EQRES
C
C
C       CALCULATE RELAXATION FUNCTION
C
C
      ABMAX=ABS(ASMAX)
      ABMIN=ABS(ASMIN)
      ABMEAN=ABS(ASMEAN)
      IF (ABMAX.LT.1.) ABMAX=1.
      IF (ABMEAN.LT.1.) ABMEAN=0.5
      IF (ABMIN-ABMAX) 444,444,442
442   ABM=ABMIN
      GO TO 446
444   ABM=ABMAX
446   ENEP=C1/(ABM**E1*ABMEAN**E2)
      IF (IPRINT.GE.3) GO TO 351
      WRITE(6,350) STMAX(J),STMIN(J),SIGMAX(IRAIN),SIGMIN(IR
     1AIN),RES(J),EQRES,ENN(J),ENEP,J,IRAIN
350   FORMAT(6(F7.2,1X),F6.2,1X,E15.8,I5,I5)
351   CONTINUE
C
C
C            CALCULATE RESIDUAL STRESS RELAXATION
C
C
      IRAIN=IRAIN+1
      ABDIF=ABS(DIF)
      GO TO 360
C
C     OMITTED "GO TO 560" CARD FROM THIS POSITION, AS SHOWN
C          IN MANUAL
C
360   IF(ABDIF.LT.5.) GO TO 560
370   IF(1000.*ENN(J).LT.ENEP) GO TO 560
      IF (ENN(J).LE.10.) GO TO 560
380   NFLAG=0
      NFLAG2=10
      IRAIN=IRAIN-1
      DUMMY=ENN(J)
450   IF (DUMMY-ENEP) 470,460,460
460   DUMMY=DUMMY/2.
      NFLAG=NFLAG+1
      GO TO 450
470   CYCINT=DUMMY/10.
      DO 500 K=1,10
      DECK=FLOAT(K)
      EN(K)=CYCINT*DECK
      IF (K.EQ.1) GO TO 490
480   EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)
      GO TO 500
490   EX(K)=1.+EXP(-2.303*EN(K)/ENEP)
500   CONTINUE
      IF(NFLAG.EQ.0) GO TO 530
510   NFLAG2=NFLAG+10
      DO 520 K=11,NFLAG2
      EN(K)=2.*DUMMY
      EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)
      DUMMY=2.*DUMMY
520   CONTINUE
530   DO 559 K=1,NFLAG2
      SIGMAX(IRAIN)=ASMAX+EQRES+DIF*EX(K)/2.
      SIGMIN(IRAIN)=SIGMAX(IRAIN)-ASMAX+ASMIN
      RNCYC(IRAIN)=EN(K)
545   IF (K.EQ.1) GO TO 540
```

```
539   RNCYC(IRAIN)=RNCYC(IRAIN)-EN(K-1)
540   IF (IPRINT.GE.3) GO TO 551
      WRITE(6,550)SIGMAX(IRAIN),SIGMIN(IRAIN),RNCYC(IRAIN),I
     1RAIN
550   FORMAT(16H RELAXATION     ,2(F7.2,1X),16X,F6.2,31X,I6)
551   CONTINUE
      IRAIN=IRAIN+1
559   CONTINUE
560   CONTINUE
      RES(I)=EQRES+DIF*EXP(-2.303*ENN(J)/ENEP)
570   CONTINUE
569   RES(1)=RES(J)
      IN=IRAIN-1
C
C
C     *************************************************
C
C                        MODULE III
C                 CYCLE COUNTING TECHNIQUE
C
C     *************************************************
C
C
C       CALL SUBROUTINE TO RANGE-PAIR COUNT SPECTRUM
C
C
      IF(IRPCM.GT.1) GO TO 591
      CALL RPCM(IN)
      GO TO 592
591   CONTINUE
      KFMAX=IN
592   CONTINUE
C
C
C     *************************************************
C
C                         MODULE IV
C               DAMAGE ACCUMULATION CALCULATION
C
C     *************************************************
C
C
      IF(IPRINT.GE.3) GO TO 552
      WRITE(6,53)
53    FORMAT(//1X,39H LOCAL STRESSES AND PLASTIC STRAINS WIT
     124HH RESULTING FATIGUE LIFE//10X,4HSTEP,10X,
     114HPLASTIC STRAIN,10X,10HMAX OR MIN,15X,6HDAMAGE)
552   CONTINUE
C
C
C        CALCULATE DAMAGE FROM PLASTIC STRAIN CYCLES
C
C
      SUMDEL=0.
      DO 531 JKL=1,NLEVEL
      AA=1.
      IF(PLSTRA(JKL)) 532,531,533
532   AA=-1.
533   PLSTRA(JKL)=AA*PLSTRA(JKL)
      CYCLES=(PLSTRA(JKL)/EPSD)**COFMAN
      DAM=1./CYCLES
      SUMNC=SUMNC+DAM
      SUMDEL=SUMDEL+DAM
      IF(IPRINT.GE.3) GO TO 531
      IF (AA) 535,535,537
535   WRITE(6,199)JKL,PLSTRA(JKL),DAM
199   FORMAT(10X,I4,12X,F10.5,15X,3HMIN,10X,E14.6)
      GO TO 531
537   WRITE(6,219)JKL,PLSTRA(JKL),DAM
219   FORMAT(10X,I4,12X,F10.5,15X,3HMAX,10X,E14.6)
531   CONTINUE
      WRITE(6,541) SUMDEL
```

```
541    FORMAT(35X,29H DAMAGE FROM PLASTIC STRAINS=,E15.8)
       IF(IPRINT.GE.3) GO TO 536
       WRITE(6,13)
13     FORMAT(/ 8X,15H SIGMAX  SIGMIN, 8X,6H RNCYC, 8X,
      125H CYCLES             ENN/CYC)
536    CONTINUE
C
C
C         CALCULATE ELASTIC CYCLE DAMAGE FROM LEAST SQUARE
C            FITTED S-N DATA (MODIFIED GOODMAN DIAGRAM FORMAT)
C
C
       DO 600 JKL=1,KPMAX
534    TTYS=TYS/5.
       IF(SIGMAX(JKL)-SIGMIN(JKL).LT.1.6*TYS) GO TO 310
       CYCLES=10.**4.
       GO TO 340
310    IF(SIGMAX(JKL).GE.TTYS) GO TO 320
447    CYCLES=10.**9.
       GO TO 340
320    N=4
       DO 330 M=1,4
       R(N)=A(N)*SIGMIN(JKL)**2+B(N)*SIGMIN(JKL)+C(N)-SIGMAX(
      1JKL)
       N=N+1
330    CONTINUE
332    IF(R(7)*R(4)) 338,338,334
334    ABR7=ABS(R(7))
       ABR4=ABS(R(4))
       IF(ABR7.LE.ABR4) GO TO 336
335    EXPO=4.+R(4)/(R(4)-R(5))
       GO TO 339
336    EXPO=7.+R(7)/(R(6)-R(7))
       GO TO 339
338    SUMR=R(4)+R(5)+R(6)+R(7)
       SUMR2=R(4)**2+R(5)**2+R(6)**2+R(7)**2
       SUMR3=R(4)**3+R(5)**3+R(6)**3+R(7)**3
       SUMR4=R(4)**4+R(5)**4+R(6)**4+R(7)**4
       SUMRN=4.*R(4)+5.*R(5)+6.*R(6)+7.*R(7)
       SUMR2N=4.*R(4)**2+5.*R(5)**2+6.*R(6)**2+7.*R(7)**2
       DEL1=4.*SUMR2*SUMR4-4.*SUMR3**2
       DEL2=SUMR*SUMR2*SUMR3-SUMR4*SUMR**2
       DEL3=SUMR*SUMR2*SUMR3-SUMR2**3
       DD1=22.*SUMR2*SUMR4-22.*SUMR3**2
       DD2=SUMR2*SUMR3*SUMRN-SUMR*SUMR4*SUMRN
       DD3=SUMR*SUMR3*SUMR2N-SUMR2N*SUMR2**2
       EXPO=(DD1+DD2+DD3)/(DEL1+DEL2+DEL3)
339    CYCLES=10.**EXPO
       IF(EXPO.LE.4.)CYCLES=10.**4.
340    ENNCYC=RNCYC(JKL)/CYCLES
       SUMNC=SUMNC+ENNCYC
       SUMDEL=SUMDEL+ENNCYC
       IF(IPRINT.GE.3) GO TO 600
       WRITE(6,599) SIGMAX(JKL),SIGMIN(JKL),RNCYC(JKL),CYCLES
      1,ENNCYC
599    FORMAT( 8X,2(F7.2,1X), 6X,F6.0, 7X,2(E15.8,1X))
600    CONTINUE
       WRITE(6,593) SUMDEL
593    FORMAT(/35X,21H DAMAGE PER THIS SET=,E15.8)
       WRITE(6,575) SUMNC
575    FORMAT(/35X,18H  TOTAL ENN/CYC =,E15.8)
       RETURN
       END
C
```

```
      SUBROUTINE RPCM(NPKS)
C     THIS PROGRAM EMPLOYS THE RANGE-PAIR CYCLE COUNTING
C     METHOD TO GENERATE ANALYSIS SPECTRUM FROM A GIVEN
C     LOAD SPECTRUM
C
C     PROGRAM ARRAYS
C     (INFORMATION NEEDED TO CHANGE DIMENSIONS)
C
C     ARRAY NAME   DEFINITION                           DIMENSION
C       SIGMAX   PEAKS OF THE INPUT LOAD SPECTRUM       NPKS + KK
C       KK       THE NUMBER OF ADDITIONAL CYCLES
C                (EXCLUDING INPUT CYCLES) WHICH
C                THE PROGRAM WILL GENERATE
C       SIGMIN   VALLEYS OF THE INPUT LOAD              NPKS + KK
C                SPECTRUM
C       RNCYC    K COUNTERS OF THE PEAKS AND            NPKS + KK
C                VALLEYS
C       NSTEP    STEP NUMBERS OF THE INPUT              NPKS + KK
C                SPECTRUM
C       RES      RESIDUE SPECTRUM                       2*NPKS
C       INDEX    STEP NUMBERS OF ELEMENTS IN RES        2*NPKS
C       CYCLE    RANGE-PAIR COUNTED CYCLES              NPKS + KK
C       RNECYC   K COUNTERS OF THE CYCLES OF THE        NPKS + KK
C                UNSORTED ANALYSIS SPECTRUM
C       NNSTEP   STEP NUMBERS OF THE ELEMENTS OF        NPKS + KK
C                THE UNSORTED ANALYSIS SPECTRUM
C       ISAVE    VALUES OF NSTEP(J) SUCH THAT           99
C                RNCYC(J) IS <1.0 AND VALUES OF
C                NSTEP(J) SUCH THAT SIGMAX(J-1)=
C                SIGMAX(J) AND SIGMIN(J-1)=SIGMIN(J)
      COMMON/MSAL/RNCYC( 4205),KPMAX,IPRINT
      COMMON/MDEC1/SIGMAX( 4205),SIGMIN( 4205)
      COMMON/MDEC2/NSTEP( 4205),LR,KMAX,KMIN,K31
      COMMON/MDECR/RES( 4205),INDEX( 4205),IND1,IND2,IND3,IN
     1D4,KIND
      COMMON/MCYG/CYCLE(200,2),RNECYC( 4205),NNSTEP( 4205)
      COMMON/MCGDE/L,LIND
      DIMENSION ISAVE(4205),TITLE(8)
 9999 NPUNCH = 0
      DO 8000 I=1,NPKS
 8000 NSTEP(I) = I
      IF(IPRINT.GE.2)GO TO 103
      WRITE(6,20)NPKS
   20 FORMAT(1H0,40HTHE NUMBER OF PEAKS OR VALLEYS IN THE IN
     120HPUT LOAD SPECTRUM = ,I5//)
      WRITE(6,22)
   22 FORMAT(39X,5HSIGMA/10X,4HSTEP,13X,7HMAXIMUM,16X,
     17HMINIMUM,12X,9HCOUNTER K/)
      WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I),I =
     1 1,NPKS)
   25 FORMAT(8X, I5,10X,E13.6,10X,E13.6,10X,F10.5)
103   CONTINUE
C
C
C     SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS
C     AND VALLEYS WHERE COUNTER K IS LESS THAN 1.0
C
C
      J=1
      L=0
      NRES = 1
      NCYNO = 100
      JMAX = 0
      DO 100 I=1,NPKS
      IF (RNCYC(I) .GE. 1.0) GO TO 100
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      CALL CYCGEN(X1,X2,RNCYC(I),NSTEP(I))
      ISAVE(J) = I
```

```
      J = J +1
  100 CONTINUE
      JMAX = J - 1
      NPKSN = NPKS - JMAX
      IF (JMAX.EQ.0) GO TO 200
      WRITE(6,23) (ISAVE(K),K = 1,JMAX)
      IF(IPRINT.GE.2)GO TO 101
   23 FORMAT(1H0,40HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS
     151HIN THE LOAD SPECTRUM WHOSE COUNTER K IS LESS THAN 1
     12H.0//(17I7))
  101 CONTINUE
      DO 110 J = 1,JMAX
      I = ISAVE(J) - (J-1)
      NPKN = NPKS - J
      IF(I.EQ.NPKN) GO TO 110
      DO 115 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
115   CONTINUE
  110 CONTINUE
  200 CONTINUE
C
C
C     SORT THROUGH THE LOAD SPECTRUM DATA-COMBINE STEPS WITH
C     IDENTICAL PEAKS AND VALLEYS WHICH OCCUR CONSECUTIVELY
C
C
      J = 1
      DO 300 I = 2,NPKSN
      IF(SIGMAX(I) .NE. SIGMAX(I-1)) GO TO 300
      IF(SIGMIN(I) .NE. SIGMIN(I-1)) GO TO 300
      ISAVE(J) = I
      RNCYC(I-1) = RNCYC(I-1) + RNCYC(I)
      J = J + 1
  300 CONTINUE
      IF (J.EQ.1) GO TO 6000
      JMAS = J - 1
      DO 311 J = 1,JMAS
      I = ISAVE(J) - (J-1)
      NPKN = NPKSN - J
      IF (I .EQ. NPKN) GO TO 311
      DO 316 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
  316 CONTINUE
311   CONTINUE
      NPKSN = NPKSN - JMAS
C
C
C     RANGE PAIR COUNT THE ADJUSTED LOAD SPECTRUM
C
C
6000  I=1
      KB=0
      L=JMAX
      KMIN=0
      KMAX=0
      LR=0
      KB1=0
1     IF (RNCYC(I) .GT. 1.0) GO TO 400
      IF (KB .NE. 0) GO TO 5
      X1=SIGMAX(I)
      X2=SIGMIN(I)
      IND1=NSTEP(I)
      IND2=IND1
      I=I+1
      KB=1
      GO TO 1
```

```
5     X3=SIGMAX(I)
      X4=SIGMIN(I)
      IND3=NSTEP(I)
      IND4=IND3
      KMIN=1
      KMAX=0
      K31=0
      IF (RNCYC(I) .EQ. 1.0) GO TO 6
      KEY=1
      KIND=1
      GO TO 415
6     KEY=0
      CYCNO=AINT(RNCYC(I)+0.5)
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
1000  GO TO (10,10,30),KCYGEN
10    KB=1
C
C
C     REVERSE ORDER OF NEXT TWO CARDS TO RUN. "I=I+1" GOES
C     AFTER "IF(KMIN.NE.1) GO TO 36" AS PER ERRATA SHEET IN
C     PRINTED MANUAL.  CHECK PROGRAM WITH CARDS IN THE
C     MANUAL'S ORDER
C
C
      IF (KMIN .NE. 1) GO TO 36
      I=I+1
      IF (I .LE. NPKSN) GO TO 5
      RES(LR+1) = X1
      RES(LR+2) = X2
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      LRMAX = LR+2
      GO TO 2000
30    IF (KMIN .NE. 1) GO TO 35
12    I=I+1
      IF (I .LE. NPKSN) GO TO 31
      RES(LR+1) = X1
      RES(LR+2) = X2
      RES(LR+3) = X3
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      INDEX(LR+3) = IND3
      LRMAX = LR+3
      GO TO 2000
31    X4=SIGMAX(I)
      IND4=NSTEP(I)
      KMAX=1
      KMIN=0
      K31=1
32    IF (RNCYC(I) .GT. 1.0) GO TO 40
      GO TO 6
40    KEY = 1
      KIND = 0
      GO TO 415
35    X4 = SIGMIN(I)
      IND4 = NSTEP(I)
      KMIN = 1
      KMAX = 0
      K31 = 0
      GO TO 32
36    X3 = SIGMIN(I)
      IND3 = NSTEP(I)
      KMIN = 1
      KMAX = 0
      GO TO 12
400   KEY = 1
      IF (KB .NE. 0) GO TO 410
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IND1 = NSTEP(I)
```

```
      IND2 = IND1
      IND3 = IND1
      IND4 = IND1
      KMIN = 1
      KMAX = 0
      K31 = 0
      IF (RNCYC(I) .LE. 2.0) GO TO 401
      RNCYC(I) = RNCYC(I) - 1.0
      GO TO 402
401   RNCYC(I) = RNCYC(I) - 2.0
402   KIND = 0
      GO TO 415
410   X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IND3 = NSTEP(I)
      IND4 = IND3
      KMIN = 1
      KMAX = 0
      K31 = 0
      KIND = 1
      RNCYC(I) = RNCYC(I) - 1.0
      KE = 0
415   CYCNO = AINT(RNCYC(I)+0.5)
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
      GO TO 1000
2000  LMAX = L
      IF (LRMAX .LT. 4) GO TO 5000
      IF (NCYNO .EQ. 0) GO TO 5000
C
C
C     RANGE PAIR COUNT OF RESIDUE SPECTRUMS
C
C
      NRES=NRES+1
      CALL DECRES(LRMAX,NCYNO)
      GO TO 2000
5000  IF (LRMAX .LE. 1) GO TO 3000
C
C
C     COUNT THE LAST RESIDUE SPECTRUM - RANGE-PAIR COUNTING
C     WILL YIELD N ADDITIONAL CYCLES
C
C
      KK=0
      RESMAX=RES(1)
      RESMIN=RES(1)
      IMAX=1
      IMIN=1
      DO 500 I=2,LRMAX
      IF (RES(I) .LT. RESMAX) GO TO 490
      RESMAX = RES(I)
      IMAX = I
      GO TO 500
490   IF (RES(I) .GT. RESMIN) GO TO 500
      RESMIN=RES(I)
      IMIN = I
500   CONTINUE
      CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))
      KK = KK+1
510   J=IMAX-2
      IF (J .LE. 0) GO TO 550
      CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))
      KK = KK+1
      IMAX = J
      GO TO 510
550   J = IMIN + 2
      IF (J .GT. LRMAX) GO TO 575
      CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))
      KK = KK+1
      IMIN = J
      GO TO 550
575   KMAX = KK
```

```
      IND2 = IND1
      IND3 = IND1
      IND4 = IND1
      KMIN = 1
      KMAX = 0
      K31 = 0
      IF (RNCYC(I) .LE. 2.0) GO TO 401
      RNCYC(I) = RNCYC(I) - 1.0
      GO TO 402
401   RNCYC(I) = RNCYC(I) - 2.0
402   KIND = 0
      GO TO 415
410   X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IND3 = NSTEP(I)
      IND4 = IND3
      KMIN = 1
      KMAX = 0
      K31 = 0
      KIND = 1
      RNCYC(I) = RNCYC(I) - 1.0
      KB = 0
415   CYCNO = AINT(RNCYC(I)+0.5)
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
      GO TO 1000
2000  LMAX = L
      IF (LRMAX .LT. 4) GO TO 5000
      IF (NCYNO .EQ. 0) GO TO 5000
C
C
C     RANGE PAIR COUNT OF RESIDUE SPECTRUMS
C
C
      NRES=NRES+1
      CALL DECRES(LRMAX,NCYNO)
      GO TO 2000
5000  IF (LRMAX .LE. 1) GO TO 3000
C
C
C     COUNT THE LAST RESIDUE SPECTRUM - RANGE-PAIR COUNTING
C     WILL YIELD N ADDITIONAL CYCLES
C
C
      KK=0
      RESMAX=RES(1)
      RESMIN=RES(1)
      IMAX=1
      IMIN=1
      DO 500 I=2,LRMAX
      IF (RES(I) .LT. RESMAX) GO TO 490
      RESMAX = RES(I)
      IMAX = I
      GO TO 500
490   IF (RES(I) .GT. RESMIN) GO TO 500
      RESMIN=RES(I)
      IMIN = I
500   CONTINUE
      CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))
      KK = KK+1
510   J=IMAX-2
      IF (J .LE. 0) GO TO 550
      CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))
      KK = KK+1
      IMAX = J
      GO TO 510
550   J = IMIN + 2
      IF (J .GT. LRMAX) GO TO 575
      CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))
      KK = KK+1
      IMIN = J
      GO TO 550
575   KMAX = KK
```

```
      LMAX = L
C
C
C     SORT THE ANALYSIS SPECTRUM TO PRODUCE THE RANGE-PAIR
C     COUNTED SPECTRUM
C
C
C
3000  KP = 0
      DO 605 JJ = 1,NPKS
      KC = 0
      DO 600 I = 1,LMAX
      IF (NNSTEP(I) .NE. JJ) GO TO 600
      KP=KP+1
      KC=KC+1
      NSTEP(KP)=KP
      SIGMAX(KP) = CYCLE(I,1)
      SIGMIN(KP) = CYCLE(I,2)
      RNCYC(KP) = RNECYC(I)
      IF (KC .LT. 2) GO TO 600
      IF (SIGMAX(KP) .NE. SIGMAX(KP-1)) GO TO 600
      IF (SIGMIN(KP) .NE. SIGMIN(KP-1)) GO TO 600
595   KP=KP-1
      RNCYC(KP)= RNCYC(KP) + 1.0
600   CONTINUE
605   CONTINUE
      KPMAX=KP
      IF (IPRINT .GE. 2) GO TO 104
      WRITE(6,2010)
2010  FORMAT(1H1,48X,33HRANGE PAIR CYCLE COUNTED SPECTRUM//)
      WRITE(6,22)
      WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I),I=1
     1,KPMAX)
102   FORMAT(5X,3F10.2)
104   CONTINUE
      RETURN
      END
C
C
C
```

```
      SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
      COMMON/MDEC1/SIGMAX( 4205),SIGMIN( 4205)
      COMMON/MDEC2/NSTEP( 4205),LR,KMAX,KMIN,K31
      COMMON/MDECR/RES( 4205),INDEX( 4205),IND1,IND2,IND3,IN
     1D4,KIND
      COMMON/MCYG/CYCLE(200,2),RNECYC( 4205),NNSTEP( 4205)
      COMMON/MCGDE/L,LIND
C
C
C     THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1,
C     X2, X3, AND X4 FROM THE ADJUSTED LOAD SPECTRUM SATISFY
C     THE RANGE-PAIR COUNTING CONDITIONS
C
C
      KFIRST=0
      IF (K31.NE.0)  GO TO 11
10    IF (X3.LE.X2) GO TO 200
11    IF (X2.GT.X1) GO TO 210
      IF (X2.LT.X4.OR.X3.GT.X1) GO TO 500
150   IF (X2.GT.X3) GO TO 151
      CALL CYCGEN(X3,X2,1.0,NSTEP(I))
      GO TO 152
151   CALL CYCGEN(X2,X3,1.0,NSTEP(I))
152   X1=X1
      X2=X4
      IF (IND3.NE.IND2) LIND=1
      IND2=IND4
      KCYGEN = 1
      IF (KEY.NE.0) GO TO 110
      RETURN
210   IF (X2.GT.X4.OR.X3.LT.X1) GO TO 500
      GO TO 150
200   X1=X1
      X2=X4
      IND2=IND4
      KCYGEN = 2
      IF (KEY.EQ.0) RETURN
      CYCNO=CYCNO-1.0
      GO TO 110
C
C
C     ADD X1 TO THE RESIDUE SPECTRUM
C
C
500   LR=LR+1
      RES(LR)=X1
      INDEX(LR)=IND1
      X1=X2
      X2=X3
      X3=X4
      IND1=IND2
      IND2=IND3
      IND3=IND4
      KCYGEN = 3
      IF (KEY.NE.0) GO TO 110
      RETURN
110   GO TO (1150,1200,1500),KCYGEN
1150  IF (CYCNO.GT.1.0) GO TO 1151
      IF (CYCNO.LE.0.0) RETURN
1153  CYCNO = CYCNO - 1.0
      GO TO 1152
1151  IF (LIND.EQ.1) GO TO 1153
      IF (IND3.NE.IND4) GO TO 1153
      RNECYC(L) = RNECYC(L) + CYCNO - 2.0
      CYCNO = 1.0
1152  IF (KMAX.NE.1) GO TO 111
      X3 = SIGMIN(I)
      IND3 = NSTEP(I)
      IF (CYCNO.GT.0.0) GO TO 112
```

```
      KMIN = 1
      KMAX = 0
      KCYGEN = 3
      RETURN
1200  IF (CYCNO.LE.0.0) RETURN
      CYCNO = CYCNO - 1.0
      X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      KFIRST = 1
      GO TO 113
111   X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IF (KFIRST.NE.0) GO TO 113
      CYCNO = CYCNO - 1.0
      KFIRST = 1
113   IND3 = NSTEP(I)
      IND4 = IND3
      KMIN = 1
      KMAX = 0
      GO TO 10
1500  IF (KMAX.NE.0) GO TO 1510
      IF (CYCNO.LE.0.0) RETURN
      CYCNO = CYCNO - 1.0
112   X4 = SIGMAX(I)
      IND4 = NSTEP(I)
      KMAX = 1
      KMIN = 0
      GO TO 11
1510  X4 = SIGMIN(I)
      IND4 = NSTEP(I)
      KMAX = 0
      KMIN = 1
      GO TO 10
      END
C
C
C
```

```
      SUBROUTINE DECRES(LRMAX,NCYNO)
      COMMON/MOGDE/L,LIND
      COMMON/MDECR/RES( 4205),INDEX( 4205),IND1,IND2,IND3,IN
     1D4,KIND
C
C
C     THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF
C     THE RESIDUE SPECTRUM SATISFY THE RANGE PAIR-COUNTING
C     CONDITIONS
C
C
      K = 0
      NCYNO = 0
      X1 = RES(1)
      X2 = RES(2)
      X3 = RES(3)
      X4 = RES(4)
      IND1 = INDEX(1)
      IND2 = INDEX(2)
      IND3 = INDEX(3)
      IND4 = INDEX(4)
      J = 4
10    IF (X2.GT.X1) GO TO 100
      IF (X2.LT.X4.OR.X3.GT.X1) GO TO 500
150   IF (X2.GT.X3) GO TO 151
      CALL CYCRES(X3,X2,1.0,IND3)
      GO TO 152
151   CALL CYCRES(X2,X3,1.0,IND2)
152   NCYNO = NCYNO + 1
      X1 = X1
      X2 = X4
      IND2 = IND4
      IF (J.EQ.LRMAX) GO TO 300
      IF ((J+1).EQ.LRMAX) GO TO 315
      X3 = RES(J+1)
      X4 = RES(J+2)
      IND3 = INDEX(J+1)
      IND4 = INDEX(J+2)
      J = J+2
      GO TO 10
100   IF (X2.GT.X4.OR.X3.LT.X1) GO TO 500
      GO TO 150
500   K = K + 1
      RES(K) = X1
      INDEX(K) = IND1
      J = J + 1
      IF (J.GT.LRMAX) GO TO 330
      X1 = X2
      X2 = X3
      X3 = X4
      X4 = RES(J)
      IND1 = IND2
      IND2 = IND3
      IND3 = IND4
      IND4 = INDEX(J)
      GO TO 10
300   K = K + 1
      RES(K) = X1
      RES(K+1) = X2
      INDEX(K) = IND1
      INDEX(K+1) = IND2
      LRMAX = K+1
      RETURN
315   K = K+1
      RES(K) = X1
      RES(K+1) = X2
      RES(K+2) = RES(J+1)
      INDEX(K) = IND1
      INDEX(K+1) = IND2
```

```
      INDEX(K+2) = INDEX(J+1)
      LRMAX = K+2
      RETURN
330   K = K+1
      RES(K) = X2
      RES(K+1) = X3
      RES(K+2) = X4
      INDEX(K) = IND2
      INDEX(K+1) = IND3
      INDEX(K+2) = IND4
      LRMAX = K+2
      RETURN
      END
C
C
C
```

```
      SUBROUTINE CYCRES(Y1,Y2,CYCPF,NSTEPP)
      COMMON/MCYG/CYCLE(200,2),RNECYC( 4205),NNSTEP( 4205)
      COMMON/MCGDE/L,LIND
C
C
C     THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS
C     SPECTRUM FROM DATA SUPPLIED BY SUBROUTINE DECRES
C
C
      L = L+1
      CYCLE(L,1) = Y1
      CYCLE(L,2) = Y2
      RNECYC(L) = CYCPF
      NNSTEP(L) = NSTEPP
      RETURN
      END
```

```
C
C
C                 RANDOMIZE SPECTRUM A LOADS FOR STMAX
C
C
      ISKIP=100
      IA=0
      IB=0
      IC=0
      ID=0
      IE=0
      IF=0
      IG=0
      IH=0
      II=0
      IJ=0
      I=1
      ITOTAL=0
      IX=9
700   CALL RANDU(IX,IY,YFL)
      IX=IY
      IF(ITOTAL.EQ.4201) GO TO 790
      IF((YFL.GE.0.).AND.(YFL.LT..1))  GO TO 750
      IF((YFL.GE..1).AND.(YFL.LT..2))  GO TO 751
      IF((YFL.GE..2).AND.(YFL.LT..3))  GO TO 752
      IF((YFL.GE..3).AND.(YFL.LT..4))  GO TO 753
      IF((YFL.GE..4).AND.(YFL.LT..5))  GO TO 754
      IF((YFL.GE..5).AND.(YFL.LT..6))  GO TO 755
      IF((YFL.GE..6).AND.(YFL.LT..7))  GO TO 756
      IF((YFL.GE..7).AND.(YFL.LT..8))  GO TO 757
      IF((YFL.GE..8).AND.(YFL.LT..9))  GO TO 758
      IF((YFL.GE..9).AND.(YFL.LT.1.))  GO TO 759
750   IF(IA.EQ.2) GO TO 700
      ITOTAL=ITOTAL+1
      IA=IA+1
      RTMAX(I)=1.25
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
751   IF(IB.EQ.4) GO TO 700
      ITOTAL=ITOTAL+1
      IB=IB+1
      RTMAX(I)=1.15
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
752   IF(IC.EQ.15) GO TO 700
      ITOTAL=ITOTAL+1
      IC=IC+1
      RTMAX(I)=1.05
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
753   IF(ID.EQ.44) GO TO 700
      ITOTAL=ITOTAL+1
      ID=ID+1
      RTMAX(I)=.95
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
754   IF(IE.EQ.136) GO TO 700
```

```
      ITOTAL=ITOTAL+1
      IE=IE+1
      RTMAX(I)=.85
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 755  IF(IK.EQ.250) GO TO 700
      ITOTAL=ITOTAL+1
      IK=IK+1
      RTMAX(I)=.75
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 756  IF(IG.EQ.450) GO TO 700
      ITOTAL=ITOTAL+1
      IG=IG+1
      RTMAX(I)=.65
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 757  IF(IH.EQ.650) GO TO 700
      ITOTAL=ITOTAL+1
      IH=IH+1
      RTMAX(I)=.55
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 758  IF(II.EQ.950) GO TO 700
      ITOTAL=ITOTAL+1
      II=II+1
      RTMAX(I)=.45
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 759  IF(IJ.EQ.1700) GO TO 700
      ITOTAL=ITOTAL+1
      IJ=IJ+1
      RTMAX(I)=.35
      RTMIN(I)=.11
      ITYPE(I)=1
      RNN(I)=1.
      I=I+1
      GO TO 700
 790  CONTINUE
C
C
C                RANDOMIZE SPECTRUM A LOADS FOR STMIN
C
C
      IA=0
      IB=0
      IC=0
      ID=0
      IE=0
      IM=0
      IG=0
      IH=0
      II=0
      IJ=0
      IK=0
      IL=0
      I=1
```

```
      ITOTAL=0
      IX=583
773   CALL RANDU(IX,IY,YFL)
      IX=IY
      IF(ITOTAL.EQ.101) GO TO 791
      IF((YFL.GE.0.).AND.(YFL.LT..06)) GO TO 760
      IF((YFL.GE..07).AND.(YFL.LT..13)) GO TO 761
      IF((YFL.GE..14).AND.(YFL.LT..20)) GO TO 762
      IF((YFL.GE..21).AND.(YFL.LT..27)) GO TO 763
      IF((YFL.GE..28).AND.(YFL.LT..34)) GO TO 764
      IF((YFL.GE..35).AND.(YFL.LT..41)) GO TO 765
      IF((YFL.GE..42).AND.(YFL.LT..48)) GO TO 766
      IF((YFL.GE..49).AND.(YFL.LT..55)) GO TO 767
      IF((YFL.GE..56).AND.(YFL.LT..62)) GO TO 768
      IF((YFL.GE..63).AND.(YFL.LT..69)) GO TO 769
      IF((YFL.GE..70).AND.(YFL.LT..76)) GO TO 770
      IF((YFL.GE..77).AND.(YFL.LT..83)) GO TO 771
      IF((YFL.GE..84).AND.(YFL.LT.1.0)) GO TO 773
760   IF(IA.EQ.50) GO TO 773
      ITOTAL=ITOTAL+1
      IA=IA+1
      HOLD(I)=0.
      I=I+1
      GO TO 773
761   IF(IB.EQ.20) GO TO 773
      ITOTAL=ITOTAL+1
      IB=IB+1
      HOLD(I)=-.04
      I=I+1
      GO TO 773
762   IF(IC.EQ.10) GO TO 773
      ITOTAL=ITOTAL+1
      IC=IC+1
      HOLD(I)=-.08
      I=I+1
      GO TO 773
763   IF(ID.EQ.6) GO TO 773
      ITOTAL=ITOTAL+1
      ID=ID+1
      HOLD(I)=-.12
      I=I+1
      GO TO 773
764   IF(IE.EQ.3) GO TO 773
      ITOTAL=ITOTAL+1
      IE=IE+1
      HOLD(I)=-.16
      I=I+1
      GO TO 773
765   IF(IM.EQ.3) GO TO 773
      ITOTAL=ITOTAL+1
      IM=IM+1
      HOLD(I)=-.20
      I=I+1
      GO TO 773
766   IF(IG.EQ.3) GO TO 773
      ITOTAL=ITOTAL+1
      IG=IG+1
      HOLD(I)=-.25
      I=I+1
      GO TO 773
767   IF(IH.EQ.2) GO TO 773
      ITOTAL=ITOTAL+1
      IH=IH+1
      HOLD(I)=-.29
      I=I+1
      GO TO 773
768   IF(II.EQ.1) GO TO 773
      ITOTAL=ITOTAL+1
      II=II+1
      HOLD(I)=-.33
      I=I+1
      GO TO 773
```

```
769   IF(IJ.EQ.1) GO TO 773
      ITOTAL=ITOTAL+1
      IJ=IJ+1
      HOLD(I)=-.37
      I=I+1
      GO TO 773
770   IF(IK.EQ.1) GO TO 773
      ITOTAL=ITOTAL+1
      IK=IK+1
      HOLD(I)=-.41
      I=I+1
      GO TO 773
771   IF(IL.EQ.1) GO TO 773
      ITOTAL=ITOTAL+1
      IL=IL+1
      HOLD(I)=-.45
      I=I+1
      GO TO 773
791   CONTINUE
C
C
C     RANDOMIZE SPECTRUM A STMIN LOADS WITH .11LL(1G.) LOADS
C       TO EQUAL NUMBER OF STMAX LOADS
C
C
      IA=0
      IB=0
      J=1
      I=1
      ITOTAL=0
      IX=4777
780   CALL RANDU(IX,IY,YFL)
      IX=IY
      IF(ITOTAL.EQ.4201) GO TO 792
      IF((YFL.GE.0.).AND.(YFL.LT..2)) GO TO 781
      IF((YFL.GE..2).AND.(YFL.LT.1.)) GO TO 782
781   IF(IA.EQ.101) GO TO 780
      ITOTAL=ITOTAL+1
      IA=IA+1
      RTMIN(J)=HOLD(I)
      I=I+1
      J=J+1
      GO TO 780
782   IF(IB.EQ.4100) GO TO 780
      ITOTAL=ITOTAL+1
      IB=IB+1
      RTMIN(J)=.11
      J=J+1
      GO TO 780
792   CONTINUE
C
C
C     ESTABLISH A GROUND CYCLE EVERY HOUR ( 42 EVENTS)
C
C
      DO 795 J=1,4201,42
      RTMIN(J)=-.08
795   CONTINUE
C
C
```

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